United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Confederated Tribes of the Warm Springs Reservation; United States Department of the Interior, Bureau of Indian Affairs; and Oregon Agricultural Experiment Station

Soil Survey of Warm Springs Indian Reservation, Oregon

How to Use This Soil Survey

General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

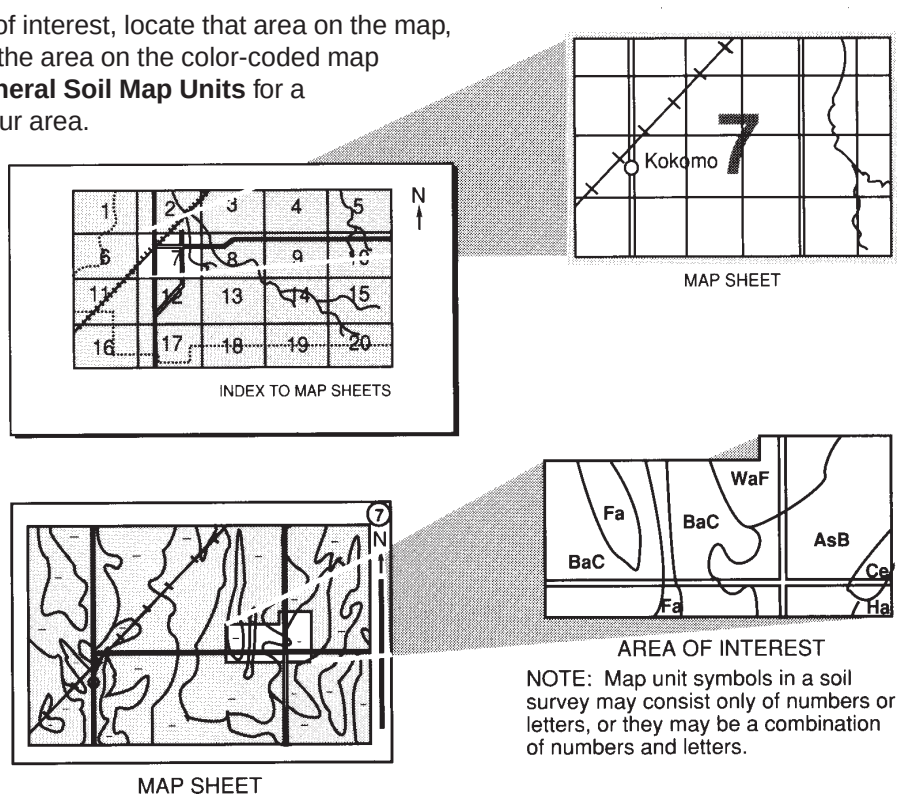
To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map units symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.



NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1992. Soil names and descriptions were approved in 1993. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1993. This survey was made cooperatively by the Natural Resources Conservation Service and the Confederated Tribes of the Warm Springs Reservation. It is part of the technical assistance furnished to the Confederated Tribes of the Warm Springs Reservation.

Since the publication of this survey, more information on soil properties may have been collected, new interpretations developed, or existing interpretive criteria modified. The most current soil information and interpretations for this survey are in the Field Office Technical Guide (FOTG) at the local office of the Natural Resources Conservation Service. The soil maps in this publication may exist in digital form in a full quadrangle format. The digitizing of the maps is in accordance with the Soil Survey Geographic (SSURGO) database standards. During the digitizing process, changes or corrections to the maps may have occurred. These changes or corrections improve the matching of this survey to adjacent surveys and correct previous errors or omissions of map unit symbols or lines. If digital SSURGO-certified maps exist for this survey, they are considered the official maps for the survey area and are part of the FOTG at the local office of the Natural Resources Conservation Service.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Mt. Jefferson; source of parent material of many of the soils in the survey area.

Additional information about the Nation's natural resources is available on the Natural Resources Conservation Service home page on the World Wide Web. The address is http://www.nrcs.usda.gov (click on "Technical Resources").

Contents

Issued 1998

Foreword

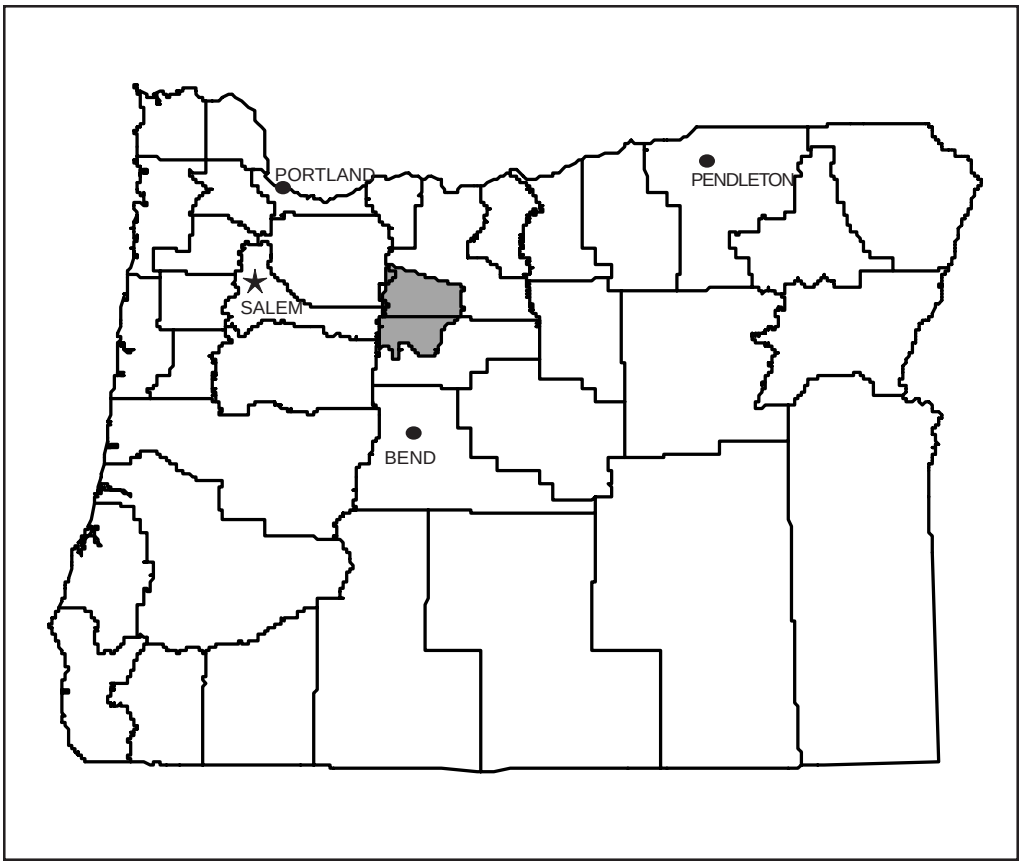
This soil survey contains information that can be used in land-planning programs on the Warm Springs Indian Reservation. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Bob Graham
State Conservationist
Natural Resources Conservation Service



Location of the Warm Springs Indian Reservation in Oregon.

Soil Survey of Warm Springs Indian Reservation, Oregon

By Gerald D. Macdonald, Natural Resources Conservation Service

Fieldwork by Gerald D. Macdonald and Todd M. Peplin, Natural Resources Conservation Service

United States Department of Agriculture, Natural Resources Conservation Service
In cooperation with
Confederated Tribes of the Warm Springs Reservation; United States Department of the Interior, Bureau of Indian Affairs; and Oregon Agricultural Experiment Station

WARM SPRINGS INDIAN RESERVATION is in the north-central part of Oregon. It has a total area of about 1,000 square miles, or 650,812 acres. Warm Springs, the seat of government, is in the east-central part of the survey area, along Tenino Creek. The population of the survey area in 1990 was about 3,200.

The eastern one-third of the survey area is steep, dissected canyons with terraces along major streams. The central one-third is nearly level mesas and outwash plains. The western one-third is mountains with broad, rolling tops and precipitous side slopes along major streams. The survey area is drained by the Warm Springs River, Shitike Creek, Seekseequa Creek, Tenino Creek, and their tributaries.

Timber is the main economic enterprise in the survey area. The climate and soils are favorable for production of ponderosa pine, Douglas fir, western hemlock, and other conifers. Also important to the economy are tourism and agriculture, including the Kah-Nee-Ta Resort and livestock and hay production.

Soil scientists have determined that there are about 74 different named soils in the survey area. Each series may include various slopes, textures, aspects, and other features. The soils are coarse sand to clay, very shallow to very deep, 0 to 60 percent rock fragments, and nearly level to very steep.

An older survey was published by Weyerhaeuser Company in 1981. This earlier survey covers part of the present survey. The present survey, however, updates the earlier survey and provides additional interpretive information and maps that show soils in greater detail.

This survey area is adjacent to the Wasco County, Oregon, Northern Part *(22)*, and Trout Creek-Shaniko Area, Oregon *(21)*, soil survey areas. Descriptions, names, and delineations of soils in this survey do not fully agree with those on soil maps for adjacent survey areas. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

General Nature of the Survey Area

This section provides general information about the survey area. It briefly discusses history and development; physiography, relief, and drainage; and climate.

History and Development

The Confederated Tribes of the Warm Springs Reservation consists of the Wasco, Warm Springs, and Paiute Indians. Long before Europeans colonized North America, the forebears of the Confederated Tribes had developed their societies along the Columbia River and the Cascade Mountains.

Although the tribes have much in common, the history and heritage of each tribe is unique. The Wasco Bands along the middle part of the Columbia River were the easternmost group of Chinook-

speaking Indians. Their closest upriver neighbors, the Warm Springs Bands who lived along the Columbia River and its tributaries, spoke Sahaptin. The Paiute Bands, who lived mainly in southeastern Oregon, were nomadic and often traveled into central Oregon. Over the centuries, the Warm Springs and Wasco Bands developed an extensive economic network along the Columbia River. This network depended on the river and its resources, particularly the salmon. The Paiute Indians, who occupied a vast territory southeast of the Columbia River, subsisted largely by hunting and gathering plants for food.

The Wasco Indians were principally fishermen and traders, and they frequently came in contact with other Indians throughout the region. They obtained surplus game food from neighboring Sahaptin Bands, roots and trade shells from the Clackamas Bands to the west, and furs, clothing, and horses from more distant eastern Indians, such as the Nez Perce Bands. In exchange, the Wasco Indians traded root bread, beargrass for making baskets, and dried salmon meal that could be stored for long periods in fish skin pouches.

While the Wasco Indians remained at their villages along the Columbia River throughout the year, the Warm Springs Bands moved between winter and summer villages. Because the Warm Springs Indians depended more on game, roots, and berries for subsistence, they needed a larger territory than did the Wasco Indians. Salmon was also an important staple for the Warm Springs Bands. Both the Wasco and Warm Springs Indians built scaffolding over the falls in rivers and used long-handled dip nets to harvest salmon and other migrating fish.

The lifestyle of the Paiute Indians was considerably different. Fish was not so important to these Indians as it was to the tribes nearer the Columbia River. The Paiute Bands that eventually settled at Warm Springs had lived in the high plateaus of Lake, Harney, and Malheur Counties in Oregon. They had to migrate widely and frequently for the plants and game needed for sustenance.

After Lewis and Clark entered the Columbia Basin in 1805, most of the contact between the tribes and non-Indians involved fur trading. In 1821, the Hudson's Bay Company built Fort Vancouver downriver from the Wasco and Warm Springs Tribes. In 1838 the Methodists established a mission at The Dalles, Oregon.

The office of the Superintendent of Indian Affairs, Oregon Territory, was established in 1848. A few years later, on June 25, 1855, the United States government signed a treaty with the Wasco and Warm Springs Tribes that established the Warm Springs Indian Reservation. The Paiute Indians joined them on the reservation 24 years later.

In 1938 the United States Congress passed the Indian Reorganization Act that provided opportunities for all Indians to elect a form of tribal government and to establish a federally charted corporation. The Confederated Tribes of the Warm Springs Reservation accepted a constitutional form of home rule, retaining the Bureau of Indian Affairs in only an advisory capacity. Leadership and management of tribal affairs became the responsibility of the Tribal Council, which is made up of eight elected members and three hereditary chiefs.

Although timber on the reservation had been cut for local use for decades, the Confederated Tribes made no commercial use of it until 1942. That year the Bureau of Indian Affairs approved a 20-year contract to cut 500 million board-feet of timber. With the proceeds of that contract, the Confederated Tribes distributed its first dividends to tribal members. In 1967 the Tribes began a major enterprise by purchasing a sawmill and plywood plant. During the 1970's and 1980's, the sawmill relied on large old-growth pine trees for production. By the end of the 1980's, the majority of old-growth pine had been liquidated. A new high-technology sawmill was opened in 1990 to accommodate smaller logs.

In 1972 Kah-Nee-Ta Lodge, a convention center, was opened near the resort village at the hot springs, which added to the job-producing enterprises of the tribes. Other business ventures of the Warm Springs Indian Reservation are the Warm Springs Power Enterprise, which was developed in 1981, and the Warm Springs Apparel Industries, which designs and markets Native American clothing.

Future economic growth on the Warm Springs Indian Reservation will depend on the proper management of timber to sustain annual harvest and development of other industries, such as agriculture and tourism.

Physiography, Relief, and Drainage

The survey area is within four major land resource areas, including the Columbia Plateau, Upper Snake River Lava Plains and Hills, Cascade Mountains (Eastern Slopes), and Cascade Mountains (Western Slopes).

The soils of the Columbia Plateau area are on gently sloping mesas and ridgetops and very steep canyonsides. This area is characterized by basalt flows with an accumulation of loess in some areas.

Elevation ranges from 1,200 feet along the northern boundary of the survey area to 3,600 feet adjacent to the Mutton Mountains.

The soils of the Upper Snake River Lava Plains and Hills area are on nearly level terraces and mesas and on gently sloping foothills to very steep canyonsides. This area is characterized by very resistant andesite and basalt, breccia, tuff, and tuffaceous siltstone northeast of the community of Warm Springs to waterlain, pumice-rich pyroclastic rock with some interbedded basalt and andesite south of Warm Springs. On the western edge of this area, widespread flows of olivine basalt cap older material. Accumulations of loess are in some areas. Elevation ranges from 1,000 feet along the Deschutes River to 4,500 feet at the summit of the Mutton Mountains.

The soils of the Cascade Mountains (Eastern Slopes) area are on nearly level to gently sloping foot slopes and outwash plains at the base of the Cascade Mountains. This area is characterized by widespread flows of basalt and andesite overlain by glacial outwash in some areas. The entire area has varying amounts of volcanic ash on the surface from past volcanic activity in the Cascade Mountains. Elevation ranges from 2,600 feet on Millcreek Flat to about 5,000 feet at the summit of Shitike and North Buttes.

The soils of the Cascade Mountains (Western Slopes) area are on gently rolling, broad ridgetops to very steep side slopes along drainagways. This area is characterized by widespread flows of andesite. The entire area is covered by deep layers of volcanic ash from past volcanic activity in the Cascade Mountains. Elevation ranges from about 2,600 feet along Beaver Creek to 10,497 feet on Mt. Jefferson. Other prominent peaks are Olallie Butte (elevation 7,216 feet) and Mt. Wilson (elevation 5,599 feet).

The northern part of the survey area is drained by Beaver Creek and the Warm Springs River, the central part by Badger, Mill, and Boulder Creeks, and the southern part by Shitike and Seekseequa Creeks and the Whitewater River. All of the watersheds generally trend from west to east and eventually drain into the Deschutes River.

Climate

Prepared by the Natural Resources Conservation Service, Water and Climate Center, Portland, Oregon.

The climate tables were created from data collected at the Government Camp, Madras, and Pelton Dam, Oregon, climate stations.

Thunderstorm days, relative humidity, percent sunshine, and wind data were estimated from first order stations at Pendleton, Oregon, and Yakima, Washington. There is no comparable first order station for Government Camp.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Government Camp, Madras, and Pelton Dam in the period 1961 to 1990. Daily extremes were extracted from the full period of record for each station. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on the length of the growing season.

In winter, the average temperature at Government Camp, Madras, and Pelton Dam is 30.7, 34.7, and 37.1 degrees F, respectively, and the average daily minimum temperature is 24.6, 24.5, and 27.0 degrees, respectively. The lowest temperature on record at Government Camp, which occurred on December 17, 1964, is -14 degrees; the lowest temperature on record at Madras, which occurred on January 21, 1930, is -40 degrees; and the lowest temperature on record at Pelton Dam, which occurred on December 8, 1972, is -15 degrees.

In summer, the average temperature at Government Camp, Madras, and Pelton Dam is 54.8, 64.7, and 69.5 degrees, respectively, and the average daily maximum temperature is 65.3, 84.3, and 89.6 degrees, respectively. The highest temperature on record at Government Camp, which occurred on August 18, 1977, is 105 degrees; the highest temperature on record at Madras, which occurred on July 25, 1928, is 112 degrees; and the highest temperature on record at Pelton Dam, which occurred on July 21, 1994, is 114 degrees.

Growing degree days are shown in table 1. They are equivalent to “heat units.” During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 86.74 inches at Government Camp, 10.61 inches at Madras, and 10.10 inches at Pelton Dam. Of the total at Government Camp, about 10.29 inches, or 12 percent, usually falls in June through September. Of the total at Madras, about 2.3 inches, or 22 percent, falls during this same period. Of the total at Pelton Dam, about 2.46 inches, or 24 percent, falls in May through September. The growing season for most crops falls within these periods. The heaviest 1-day rainfall during the period of record at each station was 5.69 inches at Government Camp on November 1, 1994;

2.14 inches at Madras on June 9, 1969; and 2 inches at Pelton Dam on December 23, 1964. Thunderstorms occur on about 10 days each year, and most occur in June.

The average seasonal snowfall is 286 inches at Government Camp, 11.4 inches at Madras, and 4.3 inches at Pelton Dam. The greatest snow depth at any one time during the period of record at each station was 180 inches recorded on March 10, 1956, at Government Camp; 14 inches recorded on January 28, 1969, at Madras; and 18 inches recorded on February 13, 1986, at Pelton Dam. On average, at least 1 inch of snow is on the ground 166 days per year at Government Camp, 15 days per year at Madras, and 2 days per year at Pelton Dam. The heaviest 1-day snowfall on record at each station was 35 inches recorded on January 9, 1980, at Government Camp; 13 inches recorded on November 5, 1973, at Madras; and 8 inches recorded on November 22, 1977, at Pelton Dam.

At Madras and Pelton Dam, the average relative humidity in midafternoon is about 44 percent. Humidity is higher at night, and the average at dawn is about 77 percent. The sun shines 80 percent of the time in summer and 30 percent in winter. The prevailing wind is from the west. Average windspeed is highest, 10 miles per hour, in April.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge gradually onto one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an nderstanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles they studied. They noted color, texture, size, and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil Taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While the soil survey was in progress, samples of some of the soils in the area were collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses and under different levels of management. Some interpretations were modified to fit local conditions, and some new interpretations were developed to meet local needs. Data were assembled from other sources, such as research information, production

records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils or miscellaneous areas can be identified on the map. Likewise, areas that are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The general map units in this survey have been grouped into general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Map Unit Descriptions

Warm, Dry Soils on Terraces and Low Foothills

This group consists of one map unit. It makes up about 2 percent of the survey area.

1. Lavey-Drybed-Madras

Moderately deep and very deep, well drained gravelly silt loam, silt loam, and loam that formed in alluvium and loess over colluvium derived from sedimentary rock and tuff

This map unit is on terraces and gently sloping foothills adjacent to the Deschutes and Warm Springs Rivers and the Dry, Shitike, and Tenino Creeks (fig. 1). The native vegetation in areas not cultivated is mainly basin big sagebrush, bluebunch wheatgrass, basin wildrye, and Sandberg bluegrass. Elevation ranges from 1,200 to 2,400 feet. Slopes range from 0 to 15 percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 110 to 160 days.

Figure 1.—Area of general soil map unit 1; community of Warm Springs in center.

This map unit makes up about 2 percent of the survey area. It is about 34 percent Lavey soils, 20 percent Drybed soils, and 19 percent Madras soils. The rest is soils of minor extent.

Lavey soils are moderately deep and well drained. The surface layer is dark brown gravelly silt loam. The subsoil is dark grayish brown clay and silty clay loam over tuff. These soils are on gently sloping, low foothills.

Drybed soils are very deep and well drained. The surface layer is very dark brown silt loam. The subsoil is very dark grayish brown silty clay loam. The substratum is brown and dark yellowish brown sandy clay loam. These soils are on stream terraces.

Madras soils are moderately deep and well drained. The surface layer is very dark grayish brown loam. The subsoil is dark brown and dark yellowish brown clay loam over tuff. These soils are on gently sloping, low foothills.Of minor extent in this unit are shallow Skoven soils and very deep Pelton and Willowdale soils. Skoven soils are on foothills, and Pelton and Willowdale soils are on flood plains adjacent to major rivers and their tributaries.

The soils in this unit are used mainly for irrigated hay and pasture, livestock grazing, and homesite development. This unit is limited by low rainfall and the hazard of soil compaction. The Lavey soils are limited by slow permeability of the subsoil and a high content of clay, which results in shrinking and swelling.

Warm, Dry Soils on High Foothills, in Canyons, and on Mesas

This group consists of three map units. It makes up about 14 percent of the survey area.

2. Simas-Ruckles-Antoken

Shallow and very deep, well drained silt loam, very cobbly loam, and extremely cobbly silt loam that formed in residuum and colluvium derived from igneous and sedimentary rock

This map unit is on foothills and in canyons on the eastern side of the survey area. The native vegetation is mainly Wyoming big sagebrush, bluebunch wheatgrass, and Sandberg bluegrass. Elevation ranges from 1,200 to 2,800 feet. Slopes range from 2 to 80 percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 110 to 160 days.

This map unit makes up about 9 percent of the survey area. It is about 21 percent Simas soils, 18 percent Ruckles soils, and 13 percent Antoken soils. The rest is soils of minor extent.

Simas soils are very deep and well drained. The surface layer is very dark brown silt loam. The upper part of the subsoil is dark brown clay, and the lower part is yellowish brown gravelly clay loam. These soils are on side slopes of foothills.

Ruckles soils are shallow and well drained. The surface layer is very dark brown very cobbly loam. The subsoil is very dark brown and dark brown very gravelly clay and extremely gravelly clay loam over tuff. These soils are on south-facing canyonsides.

Antoken soils are very deep and well drained. The surface layer is very dark grayish brown extremely cobbly silt loam. The upper part of the subsoil is dark brown and brown very cobbly clay and silty clay, and the lower part is brown and light brown extremely cobbly loam and extremely stony sandy loam. These soils are on north-facing foot slopes of canyons.

Of minor extent in this unit are deep Axford soils on north-facing canyonsides, very deep Day soils on side slopes of foothills, shallow Lickskillet soils on south-facing canyonsides, moderately deep Ruclick soils on south-facing canyonsides, moderately deep Sorf soils on south-facing side slopes of foothills, and moderately deep Walsey soils on north-facing canyonsides.

The soils in this unit are used mainly for livestock grazing and wildlife habitat. This unit is limited by low rainfall, depth to bedrock in the Ruckles soils, the hazard of soil compaction, slow permeability of the subsoil, high content of clay, and steepness of slope. The Antoken and Ruckles soils also are limited by a high content of rock fragments.

3. Bakeoven

Very shallow, well drained very cobbly loam that formed in residuum and colluvium derived from igneous rock

This map unit is on mesas on the eastern side of the survey area. The native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Wyoming big sagebrush, and buckwheat. Elevation ranges from 2,000 to 3,200 feet. Slopes range from 0 to 15 percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 110 to 160 days.

This map unit makes up about 3 percent of the survey area. It is about 64 percent Bakeoven soils. The rest is soils of minor extent.

Bakeoven soils are very shallow and well drained. The surface layer is very dark brown very cobbly loam. The subsoil is dark brown extremely cobbly clay loam over basalt. These soils are on scablands of mesas.

Of minor extent in this unit are shallow Lickskillet soils on canyonsides, moderately deep Maupin soils on mounds of mesas, and shallow Skoven soils on scablands of mesas.

The soils in this unit are used mainly for livestock grazing and wildlife habitat. This unit is limited by low rainfall, depth to bedrock, and a high content of rock fragments.

4. Dryhollow

Very deep, well drained loam that formed in residuum and colluvium derived from tephra

This map unit is in canyons adjacent to Dry Hollow and Seekseequa Creeks. The native vegetation is Wyoming big sagebrush, bluebunch wheatgrass, and Sandberg bluegrass. Elevation is 1,600 to 2,600 feet. Slopes range from 0 to 55 percent. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 110 to 160 days.

This map unit makes up about 2 percent of the survey area. It is about 78 percent Dryhollow soils. The rest is soils of minor extent.

Dryhollow soils are very deep and well drained. The surface layer is very dark brown loam. The subsoil is very dark grayish brown and dark brown loam and cobbly sandy loam. The substratum is brown gravelly and very gravelly loam. These soils are on convex ridgetops and north-facing canyonsides.

Of minor extent in this unit are moderately deep Suppah and Ruclick soils on south-facing foot slopes of canyons.

The soils in this unit are used mainly for livestock grazing and wildlife habitat. This unit is limited by low rainfall, the hazard of soil compaction, and steepness of slope.

Warm, Moist Soils in Canyons and on Mesas

This group consists of three map units. It makes up about 15 percent of the survey area.

5. Kishwalk-Waterbury

Moderately deep and shallow, well drained very stony loam and extremely stony loam that formed in colluvium derived from igneous rock

This map unit is in canyons on the eastern side of the survey area (fig. 2). The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, and antelope bitterbrush. Elevation is 1,800 to 3,000 feet. Slopes range from 2 to 80 percent. The mean annual precipitation is 12 to 14 inches, the mean annual air temperature is 48 to 50 degrees F, and the frost-free period is 100 to 140 days.

This map unit makes up about 3 percent of the survey area. It is about 40 percent Kishwalk soils and 37 percent Waterbury soils. The rest is soils of minor extent.

Kishwalk soils are moderately deep and well drained. The surface layer is very dark brown very stony loam. The upper part of the subsoil is very dark grayish brown and dark brown very stony and extremely stony clay loam, and the lower part is brown extremely stony clay over basalt. These soils are on canyonsides.

Waterbury soils are shallow and well drained. The surface layer is very dark brown extremely stony loam over very stony clay loam. The subsoil is very dark grayish brown and dark brown extremely stony clay over basalt. These soils are on south-facing canyonsides.

Of minor extent in this unit are deep Kaskela soils on foot slopes of canyons and deep Sagley soils on north-facing canyonsides.

The soils in this unit are used mainly for livestock grazing and wildlife habitat. This unit is limited by the hazard of soil compaction, slow permeability of the subsoil, steepness of slope, and a high content of rock fragments. The Waterbury soils also are limited by the depth to bedrock.

Figure 2.—Area of general soil map unit 5 on canyonsides along the Warm Springs River in foreground; area of general soil map unit 6 on nearly level mesas in background.

6. Watama-Rockly

Moderately deep and very shallow, well drained silt loam and very stony silt loam that formed in colluvium derived from igneous rock

This map unit is on mesas on the eastern side of the survey area (see fig. 2, previous page). The native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, buckwheat, and antelope bitterbrush. Elevation is 2,400 to 3,400 feet. Slopes range from 0 to 30 percent. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 48 to 50 degrees F, and the frost-free period is 100 to 140 days.

This map unit makes up about 9 percent of the survey area. It is about 52 percent Watama soils and 37 percent Rockly soils. The rest is soils of minor extent.Watama soils are moderately deep and well drained. The surface layer is very dark grayish brown silt loam. The subsoil is dark brown and dark yellowish brown silty clay loam over basalt. These soils are on mounds of mesas.

Rockly soils are very shallow and well drained. The surface layer is very dark grayish brown very stony silt loam. The subsoil is dark brown very cobbly silt loam and extremely cobbly silty clay loam over basalt. These soils are on scablands of mesas.

Of minor extent in this unit are deep Wapinitia soils on mounds of mesas and moderately deep Prill soils in areas where the mesas meet the foothills of the Mutton Mountains.

The soils in this unit are used mainly for livestock grazing and wildlife habitat. This unit is limited by the hazard of compaction of the Watama soils and by the depth to bedrock and high content of rock fragments in the Rockly soils.

7. Booten-Shiva

Very deep, well drained loam and fine sandy loam that formed in residuum and colluvium derived from tephra

This map unit is in canyons adjacent to Tenino, Dry Hollow, and Seekseequa Creeks. The native vegetation is mainly Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, arrowleaf balsamroot, lupine, and ponderosa pine. Elevation is 2,200 to 3,000 feet. Slopes range from 0 to 65 percent. The mean annual precipitation is 12 to 20 inches, the mean annual air temperature is 47 to 50 degrees F, and the frost-free period is 90 to 140 days.

This map unit makes up about 3 percent of the survey area. It is about 61 percent Booten soils and 21 percent Shiva soils. The rest is soils of minor extent.

Booten soils are very deep and well drained. The surface layer is very dark grayish brown loam. The subsoil is dark grayish brown and dark brown loam, gravelly loam, and gravelly clay loam. The substratum is brown extremely gravelly sandy loam. These soils are on benches and north-facing canyonsides.

Shiva soils are very deep and well drained. The surface layer is very dark brown fine sandy loam. The subsoil is dark brown fine sandy loam and gravelly fine sandy loam. The substratum is brown very gravelly fine sandy loam. These soils are on benches and north-facing canyonsides.

Of minor extent in this unit are shallow Evick soils on south-facing canyonsides, moderately deep Happus soils on south-facing foot slopes of canyons, and very deep Spilyay soils on south-facing foot slopes of canyons.

The soils in this unit are used mainly for livestock grazing, timber production, and wildlife habitat. This unit is limited by the hazard of soil compaction and steepness of slope.

Warm, Moist Soils on Outwash Plains

This group consists of one map unit. It makes up about 4 percent of the survey area.

8. Tenwalter-Milldam-Tolius

Shallow, moderately deep, and very deep, well drained very cobbly silt loam, silt loam, and loam that formed in glacial outwash

This map unit is on glacial outwash plains on the western side of Mill Creek and Miller Flats (see fig. 3, next page). The native vegetation is mainly Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, antelope bitterbrush, arrowleaf balsamroot, lupine, and ponderosa pine. Elevation is 2,600 to 3,000 feet. Slopes range from 0 to 8 percent. The mean annual precipitation is 12 to 20 inches, the mean annual air temperature is 47 to 50 degrees F, and the frost-free period is 90 to 140 days.

Figure 3.—Area of general soil map unit 8. The nonforested area in foreground is Tenwalter-Milldam complex, 0 to 3 percent slopes, and the forested area in background is Skooker-Tolius complex, 0 to 8 percent slopes.

This map unit makes up about 4 percent of the survey area. It is about 33 percent Tenwalter soils, 24 percent Milldam soils and 19 percent Tolius soils. The rest is soils of minor extent.

Tenwalter soils are shallow to a duripan and well drained. The surface layer is very dark grayish brown very cobbly silt loam. The subsoil is dark brown extremely cobbly clay over a duripan. These soil are on scablands of outwash plains.

Milldam soils are moderately deep to a duripan and well drained. The surface layer is very dark brown silt loam. The subsoil is dark brown silty clay loam and brown cobbly clay over a duripan. These soils are on mounds of outwash plains.

Tolius soils are very deep and well drained. The surface layer is very dark brown loam. The subsoil is dark brown sandy clay loam and sandy loam. The substratum is brown loam. These soils are on level to concave benches of outwash plains.

Of minor extent in this unit are moderately deep, somewhat poorly drained Kahneeta soils in depressional areas of outwash plains; very deep, poorly drained Olallie soils in drainageways; and deep Skooker soils in forested areas of outwash plains.

The soils in this unit are used mainly for livestock grazing, timber production, and wildlife habitat. This unit is limited by the hazard of soil compaction and by the depth to a duripan and high content of rock fragments in the Tenwalter soils.

Warm, Moist Soils on Foothills and Mountains

This group consists of three map units. It makes up about 21 percent of the survey area.

9. Prill-Kaskela-Logsprings

Moderately deep to very deep, well drained and moderately well drained gravelly silty clay loam, clay, and loam that formed in residuum and colluvium derived from tuff and sedimentary rock

This map unit is on the Mutton Mountains and Laughlin Hills (fig. 4). The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, western juniper, antelope bitterbrush, common snowberry, Oregon white oak, ponderosa pine, and Douglas fir. Elevation is 2,600 to 4,200 feet. Slopes range from 0 to 55 percent. The mean annual precipitation is 12 to 20 inches, the mean annual air temperature is 45 to 50 degrees F, and the frost-free period is 90 to 140 days.

Figure 4.—Area of general soil map unit 9. The nonforested areas are Prill-Kaskela complex, 2 to 30 percent slopes, and the forested areas are Littlefawn-Fawnspring complex, 2 to 30 percent slopes. Mutton Mountains are in background.

This map unit makes up about 7 percent of the survey area. It is about 21 percent Prill soils, 13 percent Kaskela soils, and 9 percent Logsprings soils. The rest is soils of minor extent.

Prill soils are moderately deep and well drained. The surface layer is black gravelly silty clay loam. The subsoil is very dark grayish brown and dark brown gravelly clay and extremely cobbly silty clay over tuff. These soils are on benches and side slopes of foothills.

Kaskela soils are deep and well drained. The surface layer is dark brown clay. The upper part of the subsoil is dark reddish brown and reddish brown clay, and the lower part is reddish brown clay loam over sedimentary rock. These soils are on benches and north-facing side slopes of foothills.

Logsprings soils are very deep and moderately well drained. The surface layer is dark grayish brown loam. The upper part of the subsoil is brown loam over dark brown clay, and the lower part is dark brown extremely gravelly sandy clay loam and loam. These soils are on benches of foothills.

Of minor extent in this unit are very deep Boardflower soils on benches and north-facing side slopes of mountains, shallow Bodell soils on ridgetops and south-facing side slopes of mountains, very deep and moderately well drained Dahl soils in basins, deep Fawnspring soils on benches and side slopes of mountains, moderately deep Jorn soils on south-facing mountainsides, moderately deep Littlefawn soils on north-facing mountainsides, shallow Wakamo soils on ridgetops and side slopes of mountains, and very deep Yawkola soils on south-facing mountainsides.

The soils in this unit are used mainly for livestock grazing, timber production, and wildlife habitat. This unit is limited by the hazard of soil compaction, slow permeability of the subsoil, and high content of clay.

10. Mutton-Venator-Oldsferry

Shallow, moderately deep, and very deep, well drained gravelly loam and extremely channery loam that formed in residuum and colluvium derived from tuff and sedimentary

This map unit is on the Mutton Mountains in the northeast corner of the survey area (fig. 5). The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, antelope bitterbrush, common snowberry, ponderosa pine, and Douglas fir. Elevation is 1,600 to 4,000 feet. Slopes range from 2 to 80 percent. The mean annual precipitation is 12 to 20 inches, the mean annual air temperature is 45 to 50 degrees F, and the frost-free period 90 to 140 days.

This map unit makes up about 6 percent of the survey area. It is about 35 percent Mutton soils, 12 percent Venator soils, and 11 percent Oldsferry soils. The rest is soils of minor extent.

Figure 5.—Area of general soil map unit 10. The forested areas in foreground are Mutton-Rock outcrop complex, 55 to 80 percent slopes, and the nonforested areas in background are Oldsferry-Venator-Rock outcrop complex, 55 to 80 percent slopes.

Mutton soils are very deep and well drained. The surface layer is very dark grayish brown gravelly loam. The upper part of the subsoil is dark brown gravelly loam and very gravelly loam, and the lower part is dark brown extremely gravelly loam over brown extremely stony silty clay loam. These soils are on north-facing mountainsides.

Venator soils are shallow and well drained. The surface layer is very dark grayish brown extremely channery loam. The subsoil is dark brown very channery loam and dark yellowish brown extremely channery loam over sedimentary rock. These soils are on ridgetops and south-facing side slopes of mountains.

Oldsferry soils are moderately deep and well drained. The surface layer is very dark brown extremely channery loam. The subsoil is dark brown and brown extremely channery loam over sedimentary rock. These soils are on south-facing mountainsides.

Of minor extent in this unit are deep Eaglespring soils on north-facing mountainsides, moderately deep Mowako soils on south-facing mountainsides, and shallow Wakamo soils on ridgetops and south-facing side slopes of mountains.

The soils in this unit are used mainly for livestock grazing, timber production, and wildlife habitat. This unit is limited by the hazard of soil erosion, steepness of slope, and high content of rock fragments.

11. Hehe-Teewee

Moderately deep and deep, well drained very stony loam and loam that formed in residuum and colluvium derived from igneous rock

This map unit is on the foot slopes of the Cascade Mountains, on the western side of the survey area. The native vegetation is mainly Idaho fescue, arrowleaf balsamroot, antelope bitterbrush, greenleaf manzanita, and ponderosa pine. Elevation is 2,000 to 3,500 feet. Slopes range from 0 to 65 percent. The mean annual precipitation is 14 to 25 inches, the mean annual air temperature is 45 to 49 degrees F, and the frost-free period is 80 to 120 days.

This map unit makes up about 8 percent of the survey area. It is about 59 percent Hehe soils and 25 percent Teewee soils. The rest is soils of minor extent.

Hehe soils are moderately deep and well drained. The surface layer is dark brown very stony loam. The subsoil is dark brown very bouldery loam and clay loam over andesite. These soils are on broad benches and side slopes of mountains.

Teewee soils are deep and well drained. The surface layer is dark brown loam. The upper part of the subsoil is dark brown loam and clay loam, and the lower part is dark brown very stony clay loam over andesite. These soils are on broad benches of mountains.

Of minor extent in this unit are shallow Bodell soils in scablands on broad benches of mountains.

The soils in this unit are used mainly for timber production, livestock grazing, and wildlife habitat. This unit is limited by the high content of rock fragments and steepness of slope of Hehe soils and by the hazard of compaction of the Teewee soils.

Cool, Moist Soils on Mountains

This group consists of one map unit. It makes up about 17 percent of the survey area.

12. Smiling-Simnasho-Pipp

Deep and moderately deep, well drained and somewhat excessively drained sandy loam and very stony sandy loam that formed in residuum and colluvium derived from igneous rock and volcanic ash

This map unit is on the Cascade Mountains, on the western side of the survey area (fig. 6), and on the Mutton Mountains, in the northeastern corner of the survey area. The native vegetation is mainly ponderosa pine, Douglas fir, grand fir, antelope bitterbrush, snowbrush ceanothus, common snowberry, western fescue, and Idaho fescue. Elevation is 2,600 to 5,000 feet. Slopes range from 0 to 65 percent. The mean annual precipitation is 25 to 40 inches, the mean annual air temperature is 41 to 44 degrees F, and the frost-free period is 60 to 100 days.

Figure 6.—Area of general soil map unit 12. The gently sloping areas are Smiling-Simnasho complex, 0 to 12 percent slopes, and the strongly sloping areas are Pipp very stony sandy loam, 12 to 30 percent slopes.

This map unit makes up about 17 percent of the survey area. It is about 31 percent Smiling soils, 28 percent Simnasho soils, and 25 percent Pipp soils. The rest is soils of minor extent.

Smiling soils are deep and well drained. The surface layer is dark brown sandy loam. The upper part of the subsoil is dark brown sandy loam, and the lower part is brown gravelly loam over andesite. These soils are on broad benches of mountains.

Simnasho soils are moderately deep and well drained. The surface layer is dark brown very stony sandy loam. The upper part of the subsoil is dark brown very cobbly sandy loam, and the lower part is dark yellowish brown extremely cobbly loam over andesite. These soils are on broad benches and side slopes of mountains.

Pipp soils are deep and somewhat excessively drained. The surface layer is very dark brown very stony sandy loam. The subsoil is brown and dark yellowish brown extremely stony sandy loam over andesite. These soils are on mountainsides.

Of minor extent in this unit are moderately deep Grenet and Peahke soils on south-facing mountainsides, deep Kusu soils on north-facing mountainsides, and very deep, moderately well drained Millerflat soils on stream terraces.

The soils in this unit are used mainly for timber production and wildlife habitat. This unit is limited by the steepness of slope and by the high content of rock fragments in the Pipp and Simnasho soils.

Cool, Wet Soils on Mountains

This group consists of one map unit. It makes up about 14 percent of the survey area.

13. Howash-Mackatie

Very deep and deep, somewhat excessively drained and well drained very gravelly sandy loam and sandy loam that formed in residuum and colluvium derived from igneous rock and volcanic ash

This map unit is on the Cascades Mountains, on western side of the survey area (fig. 7). The native vegetation is mainly grand fir, Douglas fir, silver fir, western hemlock, pachistima, common snowberry, vine maple, queencup beadlily, and big huckleberry. Elevation is 3,000 to 5,600 feet. Slopes range from 0 to 65 percent. The mean annual precipitation is 40 to 90 inches, the mean annual air temperature is 38 to 42 degrees F, and the frost-free period is 30 to 90 days.

Figure 7.—Area of general soil map unit 13 at the lower elevations in center and area of general soil map unit 14 at the higher elevations in background. Mt. Hood is in background.

This map unit makes up about 14 percent of the survey area. It is about 53 percent Howash soils and 26 percent Mackatie soils. The rest is soils of minor extent.

Howash soils are very deep and somewhat excessively drained. The surface layer is very dark grayish brown very gravelly sandy loam. The subsoil is brown and dark yellowish brown very gravelly and very cobbly sandy loam. The substratum is dark yellowish brown extremely cobbly loam. These soils are on mountainsides.

Mackatie soils are deep and well drained. The surface layer is dark brown sandy loam. The subsoil is dark brown loam and brown clay loam. The substratum is brown extremely cobbly clay loam over andesite. These soils are on broad benches and side slopes of mountains.

Of minor extent in this unit are moderately deep Kutcher soils on broad benches and side slopes of mountains and very deep Belrick and Douthit soils on glacial moraines.

The soils in this unit are used mainly for timber production and wildlife habitat. This unit is limited by soil wetness and by the high content of rock fragments and steepness of slope of the Howash soils.

Cold, Wet Soils on Mountains

This group consists of two map units. It makes up about 13 percent of the survey area.

14. Pinhead

Very deep, somewhat excessively drained very gravelly sandy loam that formed in residuum and colluvium derived from igneous rock and volcanic ash

This map unit is on the Cascade Mountains, in the northwestern corner of the survey area (fig. 7). The native vegetation is mainly western hemlock, Douglas fir, silver fir, noble fir, beargrass, big huckleberry, and Pacific rhododendron. Elevation is 3,400 to 5,300 feet. Slopes range from 0 to 65 percent. The mean annual precipitation is 70 to 100 inches, the mean annual air temperature is 36 to 38 degrees F, and the frost-free period is 20 to 45 days.

This map unit makes up about 5 percent of the survey area. It is about 94 percent Pinhead soils. The rest is soils of minor extent.

Pinhead soils are very deep and somewhat excessively drained. The surface layer is dark brown very gravelly sandy loam. The subsoil is dark yellowish brown extremely gravelly sandy loam. The

substratum is dark yellowish brown extremely cobbly sandy loam. These soils are on broad ridgetops and side slopes of mountains.

Of minor extent in this unit are moderately deep Jojo soils on mountainsides.

The soils in this unit are used mainly for timber production and wildlife habitat. This unit is limited by soil wetness, steepness of slope, and the high content of rock fragments.

15. Jojo-Pinhead

Moderately deep and very deep, somewhat excessively drained very stony sandy loam and very gravelly sandy loam that formed in residuum and colluvium derived from igneous rock, pyroclastic ashflow, and volcanic ash

This map unit is on the Cascade Mountains, on the western boundary of the survey area (fig. 8). The native vegetation is mainly mountain hemlock, lodgepole pine, subalpine fir, grouse blueberry, big huckleberry, and common beargrass. Elevation is 4,200 to 6,400 feet. Slopes range from 0 to 70 percent. The mean annual precipitation is 80 to 110 inches, the mean annual air temperature is 34 to 36 degrees F, and the frost-free period is 10 to 30 days.

This map unit makes up about 8 percent of the survey area. It is about 33 percent Jojo soils and 28 percent Pinhead soils. The rest is soils of minor extent.

Jojo soils are moderately deep and somewhat excessively drained. The surface layer is dark brown very stony sandy loam. The substratum is reddish brown very gravelly and extremely gravelly sandy loam and loamy sand over pyroclastic ashflow. These soils are on narrow ridgetops and side slopes of mountains.

Pinhead soils are very deep and somewhat excessively drained. The surface layer is dark brown very gravelly sandy loam. The subsoil is dark yellowish brown extremely gravelly sandy loam. The substratum is dark yellowish brown extremely cobbly sandy loam. These soils are on narrow ridgetops and side slopes of mountains.

Of minor extent in this unit are very deep, very poorly drained Mariel soils in mountain bogs, very deep Piumpsha soils on benches and side slopes of mountains, and very deep, poorly drained Racing soils in basins of mountains.

The soils in this unit are used mainly for wildlife habitat. This unit is limited by soil wetness, the high content of rock fragments, and steepness of slope. The Jojo soils also are susceptible to windthrow because of the limited rooting depth.

Figure 8.—Area of general soil map unit 15. The steep, forested areas in foreground are Jojo-Rock outcrop complex, 30 to 70 percent slopes, and the nonforested areas in background are Glaciers-Rubble land complex, 20 to 80 percent slopes.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit is given under "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavior divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included aras of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such and scape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the underlying layers, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying layers. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Pipp very stony sandy loam, 12 to 30 percent slopes, is one of several phases in the Pipp series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of

the soils or miscellaneous areas are somewhat similar in all areas. Mackatie-Kutcher complex, 0 to 12 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rubble land-Rock outcrop complex, 30 to 80 percent slopes, is an example.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Table of Contents") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils or miscellaneous areas.

In the map unit descriptions that follow, a semitabular format is used. In this format a boldface heading (for example, *Composition*) is used to identify the kind of information grouped directly below it. Introducing each item of information under the heading is an italicized term or phrase (for example, *Landscape position:*) that identifies or describes the information. Many of the boldface headings and introductory terms or phrases are self-explanatory; however, some of them need further explanation. These explanations are provided in the following paragraphs, generally in the order in which they are used in the map unit descriptions.

Composition is given for the components identified in the name of the map unit as well as for the contrasting inclusions.

Inclusions are areas of components (soils or miscellaneous areas) that differ from the components for which the unit is named. Inclusions can be either similar or contrasting. *Similar inclusions* are components that differ from the components for which the unit is named but that for purposes of use and management can be considered to be the same as the named components. Note that in the "Composition" paragraph a single percentage is provided for a named soil and the similar inclusions because their use and management are similar.

Contrasting inclusions are components that differ sufficiently from the components for which the unit is named that they would have different use and management if they were extensive enough to be managed separately. For most uses, contrasting inclusions have limited effect on use and management. Inclusions generally are in small areas, and they could not be mapped separately because of the scale used. Some small areas of strongly contrasting inclusions are identified by a special symbol on the detailed soil maps. A few inclusions may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the inclusions on the landscape.

Landscape position refers to the dominant position or positions on the landform or landforms on which the component is located. In naming landscape positions, an effort has been made to give the specific position of the component rather than a general position that could encompass other components. For some landforms, such as nearly level stream terraces, distinctive landscape positions cannot be described and thus are not given.

Landform refers to the dominant three-dimensional part or parts of the land surface on which the component is located. In naming landforms, an effort has been made to name the specific landform on which the component occurs. In some instances, however, the component may occur on more than one landform.

Typical profile is a vertical, two-dimensional section of the soil extending from the surface to a restrictive layer or to a depth of 60 inches or more.

Depth is an adjective term (for example, moderately deep) for the depth of the soil.

Permeability is the quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil.

Available water capacity is the capacity of the soil to hold water available for use by most plants. It commonly is expressed as inches of water per inch of soil (see "Glossary").

Hazard of erosion refers to the hazard if protective plant cover is removed. The hazard of erosion is constant and cannot be increased or reduced.

Major uses are the dominant uses at the time the major part of the fieldwork for this survey was completed.

Major management limitations are those factors that affect the use of the soils for the major uses. The soil-related factors are limiting, whereas the climatic factors can be either limiting or nonlimiting. The major management limitations may apply to the entire unit or to a given component of the unit.

Use and management provides additional perspective on the suitability and limitations of the unit for the major uses. It may apply to the entire unit or to a given component of the unit.

Map Unit Descriptions

1—Allingham sandy loam, 0 to 3 percent slopes

Composition

Allingham soil: 75 percent
Contrasting inclusions: 25 percent

Setting

Landform: Stream terraces
Parent material: Mixed alluvium and glacial outwash with a mantle of volcanic ash
Elevation: 2,000 to 3,200 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, common snowberry, golden chinkapin, starflower, and willow
Climatic factors:
- Mean annual precipitation—0 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 15 inches—very dark grayish brown sandy loam
15 to 33 inches—dark yellowish brown loam and gravelly loam
33 to 60 inches—dark yellowish brown very gravelly clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Vitrandic Haploxerolls along drainageways

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, soil displacement, and plant competition

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer is subject to a moderate hazard of soil compaction.
- Restricting the use of equipment to periods when the soil is dry or frozen reduces compaction.
- Using designated skid trails minimizes soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Competing vegetation can be reduced by mechanical or chemical treatment.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER-SYMPH

2—Antoken extremely cobbly silt loam, 30 to 55 percent slopes

Composition

Antoken soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes (fig. 9)
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, big sagebrush, milkvetch, and Sandberg bluegrass
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Figure 9.—Typical area of Antoken extremely cobbly silt loam, 30 to 55 percent slopes, on steep, north-facing slopes in background; Lavey gravelly silt loam, 2 to 15 percent slopes, on low foothills in foreground.

Typical Profile

0 to 6 inches—very dark grayish brown extremely cobbly silt loam
6 to 10 inches—very dark grayish brown very cobbly silty clay loam
10 to 30 inches—dark brown very cobbly clay and silty clay
30 to 60 inches—light brown extremely cobbly loam and extremely stony sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Walsey soils on convex side slopes
- Axford soils on concave side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, surface cobbles, and slope

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

- Steep slopes and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty North 10-12 PZ (Droughty North Exposure)

3—Aridic Haploxerolls, 30 to 80 percent slopes

Composition

Aridic Haploxerolls: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Terrace escarpments
Parent material: Medium- or coarse-textured alluvium derived from mixed sources
Elevation: 1,400 to 1,600 feet
Native plants: Wyoming big sagebrush, Sandberg bluegrass, bluebunch wheatgrass, western juniper, and antelope bitterbrush
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Reference Profile

0 to 10 inches—very dark grayish brown very stony loam
10 to 17 inches—dark brown very cobbly loam
17 to 33 inches—dark brown extremely gravelly sandy loam
33 to 38 inches—dark brown extremely gravelly sandy clay loam
38 to 60 inches—dark brown extremely gravelly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Ruckles soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Droughtiness, surface stones, and slope

Use and Management

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of stones or cobbles on the surface and steep slopes.
- Steep slopes affect livestock distribution.

Wildlife habitat

- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty South 9-12 PZ (Droughty South Exposure)

4—Axford-Walsey complex, 2 to 30 percent slopes

Composition

Axford soil: 50 percent
Walsey soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Axford—concave, north-facing side slopes; Walsey—convex, north-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,200 to 2,800 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, big sagebrush, milkvetch, and Sandberg bluegrass
Climatic factors:

- Mean annual precipitation—9 to 12 inches

- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Axford Soil

0 to 11 inches—very dark brown silt loam
11 to 24 inches—dark brown clay loam
24 to 46 inches—yellowish brown silt loam and gravelly silt loam
46 inches—weathered basalt

Properties and Qualities of the Axford Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 6 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Walsey Soil

0 to 11 inches—very dark brown extremely cobbly silt loam
11 to 19 inches—dark brown very cobbly silty clay loam
19 to 39 inches—brown very gravelly loam and extremely gravelly silt loam
39 inches—weathered basalt

Properties and Qualities of the Walsey Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Antoken and Day soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Axford and Walsey—droughtiness and soil compaction
- Walsey—surface cobbles

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical on the Walsey soil because of the cobbles on the surface.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty North 10-12 PZ (Droughty North Exposure)

5—Bakeoven extremely gravelly loam, 0 to 8 percent slopes

Composition

Bakeoven soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landform: Mesas
Parent material: Residuum and colluvium derived from basalt
Elevation: 2,000 to 2,400 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, and lomatium
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown extremely gravelly loam

3 to 9 inches—dark brown very cobbly loam and extremely cobbly clay loam
9 inches—basalt

Soil Properties and Qualities

Depth: Very shallow (6 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 6 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Maupin soils on mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock and droughtiness

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the limited soil depth.
- Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Very Shallow Loam 10-14 PZ (Scabland)

6—Bakeoven extremely stony loam, 0 to 8 percent slopes

Composition

Bakeoven soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Scablands
Landform: Mesas
Parent material: Residuum and colluvium derived from basalt
Elevation: 2,000 to 3,200 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, and lomatium
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown extremely stony loam
3 to 9 inches—dark brown very cobbly loam and extremely cobbly clay loam
9 inches—basalt

Soil Properties and Qualities

Depth: Very shallow (6 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 6 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight to Moderate

Contrasting Inclusions

- Maupin soils on mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock, droughtiness, and surface stones

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the limited soil depth.
- Low annual precipitation and shallow rooting depth

limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the stones on the surface.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Very Shallow Loam 10-14 PZ (Scabland)

7—Bakeoven very cobbly loam, 2 to 15 percent slopes

Composition

Bakeoven soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Scablands
Landform: Mesas
Parent material: Residuum and colluvium derived from basalt
Elevation: 2,000 to 3,200 feet
Native plants: Stiff sagebrush, Sandberg bluegrass, and lomatium
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown very cobbly loam
3 to 9 inches—dark brown very cobbly loam and extremely cobbly clay loam
9 inches—basalt

Soil Properties and Qualities

Depth: Very shallow (6 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 6 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Lickskillet soils on side slopes
- Maupin soils on mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock, droughtiness, and surface cobbles

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the limited soil depth.
- Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the cobbles on the surface.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Very Shallow Loam 10-14 PZ (Scabland)

8—Bakeoven-Maupin complex, 0 to 8 percent slopes

Composition

Bakeoven soil: 55 percent
Maupin soil: 35 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Bakeoven—scablands of patterned ground; Maupin—mounds of patterned ground

Landform: Mesas
Parent material: Bakeoven—residuum and colluvium derived from basalt with an influence of loess; Maupin—loess
Elevation: 2,000 to 2,400 feet
Native plants: Bakeoven—stiff sagebrush, Sandberg bluegrass, and lomatium; Maupin—bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Bakeoven Soil

0 to 3 inches—very dark brown extremely gravelly loam
3 to 9 inches—dark brown very cobbly loam and extremely cobbly clay loam
9 inches—basalt

Properties and Qualities of the Bakeoven Soil

Depth: Very shallow (6 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 6 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Maupin Soil

0 to 7 inches—very dark grayish brown silt loam
7 to 20 inches—dark brown silt loam
20 to 25 inches—brown gravelly loam
25 to 31 inches—indurated duripan
31 inches—basalt

Properties and Qualities of the Maupin Soil

Depth: Moderately deep to a duripan (20 to 40 inches); moderately deep to bedrock (25 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Skoven soils on scablands

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Bakeoven and Maupin—droughtiness
- Bakeoven—depth to bedrock
- Maupin—seepage and soil compaction

Use and Management

Livestock grazing

- Pond development generally is impractical because of the limited depth of the Bakeoven soil and the risk of seepage in the Maupin soil.
- Low annual precipitation of the soils and shallow rooting depth of the Bakeoven soil limit the choice of species for range seeding to drought-tolerant varieties.
- Grazing on the Maupin soil during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat

- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Bakeoven—Very Shallow Loam 10-14 PZ (Scabland)
- Maupin—Droughty Loam 8-10 PZ (Arid Rolling Hills)

9—Belrick-Douthit complex, 0 to 12 percent slopes

Composition

Belrick soil: 50 percent
Douthit soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Belrick—level benches; Douthit—convex benches and side slopes
Landform: Glacial moraines
Parent material: Glacial till and volcanic ash
Elevation: 3,200 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, and common snowberry
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile of the Belrick Soil

0 to 15 inches—very dark grayish brown fine sandy loam
15 to 37 inches—dark brown cobbly fine sandy loam
37 to 65 inches—dark brown very stony sandy loam and extremely stony sand

Properties and Qualities of the Belrick Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Douthit Soil

0 to 16 inches—dark brown very cobbly sandy loam
16 to 60 inches—dark brown extremely stony sandy loam and extremely cobbly loamy sand

Properties and Qualities of the Douthit Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Howash soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Belrick and Douthit—plant competition
- Belrick—soil compaction and displacement
- Douthit—equipment operability, seedling mortality, and fire damage

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Belrick soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- On the Douthit soil, the seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Douthit soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure

should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY and ABGR/SYMPH

10—Bluesters gravelly sandy loam, 15 to 40 percent slopes

Composition

Bluesters soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Side slopes
Landform: Cinder cones
Parent material: Volcanic ash and cinders
Elevation: 3,800 to 4,800 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 18 inches—dark brown gravelly sandy loam
18 to 60 inches—reddish brown cinders

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: More than 60 inches

Contrasting Inclusions

- Smiling soils on concave foot slopes
- Simnasho soils on convex foot slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Use and Management

Timber production
- This soil is susceptible to raveling because of the coarse texture and limited cohesiveness of the particles.
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the poor anchoring capability of the cinders.
- Unless site preparation is adequate, competition from undesirable plants can prevent reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER-CEVE and MIXED CONIFER-SYMPH

11—Boardflower loam, 2 to 20 percent slopes

Composition

Boardflower soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Benches and north-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 8 inches—dark brown loam
8 to 25 inches—dark brown loam
25 to 34 inches—dark brown clay loam
34 to 60 inches—dark brown clay

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 8 to 14 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Littlefawn soils on benches
- Mutton soils on side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- This soil is subject to a severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH

12—Bodell very cobbly loam, 30 to 55 percent slopes

Composition

Bodell soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from basalt with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and antelope bitterbrush
Climatic factors:

- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 4 inches—dark brown very cobbly loam
4 to 14 inches—dark brown very gravelly loam and extremely gravelly clay loam
14 inches—basalt

Soil Properties and Qualities

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Jorn soils on forested convex side slopes
- Yawkola soils on forested concave foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock, droughtiness, surface cobbles, slope, and aspect

Use and Management

Livestock grazing
- Shallow rooting depth limits the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Shallow Slopes 14-20 PZ

13—Bodell very stony loam, 0 to 3 percent slopes

Composition

Bodell soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Benches
Landform: Mountains
Parent material: Residuum and colluvium derived from basalt with an influence of volcanic ash
Elevation: 2,600 to 3,300 feet
Native plants: Onespike oatgrass, Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue
Climatic factors:

- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 4 inches—dark brown very stony loam
4 to 14 inches—dark brown extremely cobbly clay loam
14 inches—basalt

Soil Properties and Qualities

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Hehe soils on convex positions

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock and surface stones

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the limited soil depth.
- Range seeding with ground equipment is impractical because of the stones on the surface.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Moist Scabland 14-18 PZ

14—Bodell-Jorn complex, 2 to 30 percent slopes

Composition

Bodell soil: 50 percent
Jorn soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Bodell—shoulders and convex, south-facing side slopes; Jorn—concave, south-facing side slopes
Landform: Mountains
Parent material: Bodell—residuum and colluvium derived from basalt with an influence of volcanic ash; Jorn—residuum and colluvium derived from sedimentary rock with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Bodell—bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and antelope bitterbrush; Jorn—ponderosa pine, Douglas fir, Oregon white oak, antelope bitterbrush, and Idaho fescue
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Bodell Soil

0 to 4 inches—dark brown very cobbly loam
4 to 14 inches—dark brown very gravelly loam and extremely gravelly clay loam
14 inches—basalt

Properties and Qualities of the Bodell Soil

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Jorn Soil

0 to 5 inches—very dark brown cobbly silt loam
5 to 12 inches—very dark grayish brown gravelly silty clay loam
12 to 21 inches—dark brown gravelly silty clay
21 to 24 inches—dark brown gravelly silty clay
24 inches—sedimentary rock

Properties and Qualities of the Jorn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Yawkola soils on concave side slopes
- Kaskela soils on nonforested foot slopes

Major Uses

- Bodell and Jorn—livestock grazing and wildlife habitat
- Jorn—timber production

Major Management Limitations

Timber production
- Jorn—equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Bodell and Jorn—soil compaction
- Bodell—depth to bedrock

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- This unit is subject to a severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth of the Jorn soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- Pond development on the Bodell soil generally is impractical because of the limited soil depth.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- Jorn—PIPO-PSME/PUTR (Mutton)

Range Site

- Bodell—Shallow Slopes 14-20 PZ

15—Booten loam, 0 to 12 percent slopes

Composition

Booten soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Nearly level benches
Landform: Canyons

Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 13 inches—very dark grayish brown loam
13 to 23 inches—dark grayish brown loam
23 to 44 inches—dark brown gravelly loam and gravelly clay loam
44 to 60 inches—brown extremely gravelly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 11 to 18 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Teewee soils on level benches
- Hehe soils on convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, seedling mortality, and plant competition

Livestock grazing
- Seepage and soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- The surface layer is subject to a severe soil compaction hazard because of the texture of the soil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

16—Booten loam, 12 to 30 percent slopes

Composition

Booten soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 13 inches—very dark grayish brown loam
13 to 23 inches—dark grayish brown loam
23 to 44 inches—dark brown gravelly loam and gravelly clay loam
44 to 60 inches—brown extremely gravelly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 11 to 18 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Teewee soils on concave side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce sheet and rill erosion.
- Cuts and fills should have a ratio of more than 2 to 1 to allow for long-term establishment of vegetation.
- Use water bars; relief culverts; road surface insloping, outsloping, or crowning; sediment traps; and undulating road grades to reduce erosion and sedimentation.
- Roads and landings can be protected from erosion by applying mulch or seeding cuts and fills.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

17—Booten loam, 30 to 65 percent slopes

Composition

Booten soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches

- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 13 inches—very dark grayish brown loam
13 to 23 inches—dark grayish brown loam
23 to 44 inches—dark brown gravelly loam and gravelly clay loam
44 to 60 inches—brown extremely gravelly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 11 to 18 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Teewee soils on concave side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, and plant competition

Livestock grazing
- Slope and soil compaction

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Avoid constructing roads at midslope. Midslope roads require large cuts and fills that remove land from production.
- Spoil from excavations is subject to rill and gully erosion and to sloughing.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Steep slopes may adversely affect livestock distribution.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

18—Booten-Spilyay complex, 0 to 12 percent slopes

Composition

Booten soil: 55 percent
Spilyay soil: 35 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Booten—level and concave benches; Spilyay—convex benches and side slopes

Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice, and semiconsolidated conglomerate and tuff
Elevation: 2,200 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:

- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Booten Soil

0 to 13 inches—very dark grayish brown loam
13 to 23 inches—dark grayish brown loam
23 to 44 inches—dark brown gravelly loam and gravelly clay loam
44 to 60 inches—brown extremely gravelly sandy loam

Properties and Qualities of the Booten Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 11 to 18 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Spilyay Soil

0 to 8 inches—very dark grayish brown very cobbly loam
8 to 15 inches—dark brown clay loam
15 to 41 inches—dark yellowish brown clay
41 to 60 inches—dark brown silt loam

Properties and Qualities of the Spilyay Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 8 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Hehe soils on convex benches

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production

- Booten and Spilyay—soil compaction, seedling mortality, and plant competition
- Booten—seepage
- Spilyay—windthrow hazard and fire damage

Livestock grazing

- Booten and Spilyay—soil compaction
- Booten—seepage

Use and Management

Timber production

- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture.
- Trees on the Spilyay soil are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Spilyay soil.

Livestock grazing

- Pond development on the Booten soil generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

19—Dahl silty clay, 0 to 3 percent slopes

Composition

Dahl soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Basins
Landform: Mountains
Parent material: Mixed alluvium and colluvium derived dominantly from sedimentary rock
Elevation: 2,500 to 2,700 feet
Native plants: Tufted hairgrass, rush, sedge, and bluegrass
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 3 inches—dark gray silty clay
3 to 27 inches—dark gray silty clay
27 to 35 inches—brown silty clay loam
35 to 45 inches—brown silt loam
45 to 60 inches—brown silty clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Permeability: Slow
Available water capacity: 7 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Kaskela soils on convex positions

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Shrink-swell potential and soil compaction

Use and Management

Livestock grazing
- If this unit is seeded, use plants that tolerate the high shrink-swell potential.
- Grazing during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat
- On critical range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Mountain Meadow (Wet Mountain Meadow)

20—Day clay, 0 to 12 percent slopes

Composition

Day soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Nearly level benches
Landform: Foothills
Parent material: Residuum and colluvium derived dominantly from sedimentary rock
Elevation: 1,200 to 2,400 feet
Native plants: Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 8 inches—dark red clay
8 to 39 inches—dark red clay
39 to 60 inches—red clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Very slow
Available water capacity: 7 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Simas soils on strongly sloping positions

Major Uses

- Livestock grazing

Major Management Limitations

- Droughtiness, shrink-swell potential, and soil compaction

Use and Management

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- If this soil is seeded, use plants that tolerate the high shrink-swell potential.
- Grazing during wet periods can cause severe soil compaction and damage plants.

Range Site

- JD Gumbo 9-12 PZ (Adobeland)

21—Day complex, 8 to 40 percent slopes

Composition

Day clay: 50 percent
Day very stony silty clay: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Shoulders and side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from sedimentary rock
Elevation: 1,200 to 2,400 feet
Native plants: Bluebunch wheatgrass, Wyoming big sagebrush, Thurber needlegrass, western juniper, and antelope bitterbrush
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Day Clay

0 to 8 inches—dark red clay
8 to 39 inches—dark red clay
39 to 60 inches—red clay loam

Typical Profile of the Day Very Stony Silty Clay

0 to 8 inches—dark red very stony silty clay
8 to 39 inches—dark red clay
39 to 60 inches—red clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Very slow
Available water capacity: 7 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Antoken soils on north-facing side slopes
- Simas soils on south-facing side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Droughtiness, shrink-swell potential, surface stones, and soil compaction

Use and Management

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- If this unit is seeded, use plants that tolerate the high shrink-swell potential.
- Range seeding with ground equipment is impractical in some areas of this unit because of the stones on the surface.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat

- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- South 10-12 PZ (Juniper South Exposure)

22—Day-Antoken complex, 30 to 55 percent slopes

Composition

Day soil: 50 percent
Antoken soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons and foothills
Parent material: Day—residuum and colluvium derived from sedimentary rock; Antoken—residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,200 to 2,400 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, and big sagebrush
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Day Soil

0 to 8 inches—dark red silty clay loam
8 to 39 inches—dark red clay
39 to 60 inches—red clay loam

Properties and Qualities of the Day Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Very slow
Available water capacity: 7 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Antoken Soil

0 to 6 inches—very dark grayish brown extremely cobbly silt loam
6 to 10 inches—very dark grayish brown very cobbly silty clay loam
10 to 30 inches—dark brown very cobbly clay and silty clay
30 to 60 inches—light brown extremely cobbly loam and extremely stony sandy loam

Properties and Qualities of the Antoken Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Simas soils on concave side slopes
- Sorf soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Day and Antoken—droughtiness and slope
- Day—shrink-swell potential and soil compaction
- Antoken—surface cobbles

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- If the Day soil is seeded, use plants that tolerate the high shrink-swell potential.
- Steep slopes and cobbles on the surface of the Antoken soil may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing on the Day soil during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty North 10-12 PZ (Droughty North Exposure)

23—Douthit very stony sandy loam, 30 to 65 percent slopes

Composition

Douthit soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Side slopes
Landform: Glacial moraines
Parent material: Glacial till and volcanic ash
Elevation: 3,200 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, and common snowberry
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile

0 to 16 inches—dark brown very stony sandy loam
16 to 60 inches—dark brown extremely stony sandy loam and extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Belrick soils on concave side slopes
- Howash soils on lower, convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Disturbance of this soil may result in instability of the slope. Factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Spoil from excavations is subject to rill and gully erosion and to sloughing.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging may be restricted during November through April because of soil wetness.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.

- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY and ABGR/SYMPH

24—Douthit-Belrick complex, 12 to 30 percent slopes

Composition

Douthit soil: 60 percent
Belrick soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Belrick—concave side slopes; Douthit—convex side slopes
Landform: Glacial moraines
Parent material: Glacial till and volcanic ash
Elevation: 3,200 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, and common snowberry
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile of the Douthit Soil

0 to 16 inches—dark brown very cobbly sandy loam
16 to 60 inches—dark brown extremely stony sandy loam and extremely cobbly loamy sand

Properties and Qualities of the Douthit Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Belrick Soil

0 to 15 inches—very dark grayish brown fine sandy loam
15 to 37 inches—dark brown cobbly fine sandy loam
37 to 65 inches—dark brown very stony sandy loam and extremely stony sand

Properties and Qualities of the Belrick Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Howash soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Douthit and Belrick—equipment operability, soil displacement, and plant competition
- Douthit—seedling mortality and fire damage
- Belrick—soil compaction

Use and Management

Timber production
- On the Belrick soil, reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Belrick soil is subject to a moderate soil compaction hazard because of the texture and low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- On the Douthit soil, the seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Douthit soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY and ABGR/SYMPH

25—Drybed silt loam, 0 to 8 percent slopes

Composition

Drybed soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landform: Stream terraces
Parent material: Alluvium derived from mixed sources with an influence of loess in the upper part
Elevation: 1,200 to 2,000 feet
Native plants: Basin wildrye, bluegrass, slender wheatgrass, and basin big sagebrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 13 inches—very dark brown silt loam
13 to 29 inches—very dark grayish brown silty clay loam
29 to 60 inches—brown sandy clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 9 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Pelton soils adjacent to stream channels

Major Uses

- Cropland (see fig. 10, next page), livestock grazing, and wildlife habitat

Major Management Limitations

Cropland
- Permeability, soil erosion, and soil compaction

Livestock grazing
- Droughtiness and soil compaction

Use and Management

Cropland
- Low annual precipitation restricts annual cropping unless supplemental irrigation is used.
- Because of the moderately slow permeability of the subsoil, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.

Figure 10.—Alfalfa hay in an area of Drybed silt loam, 0 to 8 percent slopes, adjacent to Tenino Creek.

- Care should be taken when using surface irrigation on slopes of more than 3 percent.
- Because the surface layer is silt loam, this soil is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- To reduce siltation and maintain temperatures of streams, areas of this soil adjacent to perennial streams may need to be maintained as buffers.

Range Site

- Loamy Bottom (Moist Bottom)

26—Dryhollow loam, 0 to 12 percent slopes

Composition

Dryhollow soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Slightly convex ridgetops
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 1,600 to 2,600 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown loam
3 to 11 inches—very dark grayish brown loam
11 to 35 inches—dark brown loam and cobbly sandy loam
35 to 60 inches—brown gravelly and very gravelly loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 10 to 20 inches

Potential rooting depth: More than 60 inches
Run off: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Suppah soils on shoulders

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, seepage, and soil compaction

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Loamy 10-12 PZ (Juniper Rolling Hills)

27—Dryhollow loam, 12 to 30 percent slopes

Composition

Dryhollow soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 1,600 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, big sagebrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown loam
3 to 11 inches—very dark grayish brown loam
11 to 35 inches—dark brown loam and cobbly sandy loam
35 to 60 inches—brown gravelly and very gravelly loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 10 to 20 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Suppah soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness and soil compaction

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Sandy North 9-12 PZ (Sandy North Exposure)

28—Dryhollow loam, 30 to 55 percent slopes

Composition

Dryhollow soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 1,600 to 2,600 feet
Native plants: Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, big sagebrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 3 inches—very dark brown loam
3 to 11 inches—very dark grayish brown loam
11 to 35 inches—dark brown loam and cobbly sandy loam
35 to 60 inches—brown gravelly and very gravelly loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 10 to 20 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Suppah soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, slope, and soil compaction

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Sandy North 9-12 PZ (Sandy North Exposure)

29—Eaglespring channery loam, 12 to 30 percent slopes

Composition

Eaglespring soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Colluvium and residuum derived from sedimentary rock with an influence of volcanic ash
Elevation: 1,600 to 3,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 16 inches

- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 7 inches—black channery loam
7 to 13 inches—very dark brown very channery loam
13 to 43 inches—dark brown extremely channery sandy loam
43 inches—fractured sedimentary rock

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Oldsferry soils on convex side slopes
- Rock outcrop on convex shoulders
- Shiva soils on convex shoulders

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Seepage and soil compaction

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD North 12-16 PZ (North Exposure)

30—Eaglespring channery loam, 30 to 55 percent slopes

Composition

Eaglespring soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Colluvium and residuum derived from sedimentary rock with an influence of volcanic ash
Elevation: 1,600 to 3,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 7 inches—black channery loam
7 to 13 inches—very dark brown very channery loam
13 to 43 inches—dark brown extremely channery sandy loam
43 inches—fractured sedimentary rock

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Oldsferry soils on convex side slopes
- Rock outcrop on upper, convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Slope and soil compaction

Use and Management

Livestock grazing
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD North 12-16 PZ (North Exposure)

31—Eaglespring-Rock outcrop complex, 55 to 80 percent slopes

Composition

Eaglespring soil: 55 percent
Rock outcrop: 30 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Colluvium and residuum derived from sedimentary rock with an influence of volcanic ash
Elevation: 1,600 to 3,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Eaglespring Soil

0 to 7 inches—black channery loam
7 to 13 inches—very dark brown very channery loam
13 to 43 inches—dark brown extremely channery sandy loam
43 inches—fractured sedimentary rock

Soil Properties and Qualities of the Eaglespring Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Very rapid
Hazard of erosion: Very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Oldsferry soils on convex side slopes
- Venator soils adjacent to Rock outcrop

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Slope, Rock outcrop, and soil compaction

Use and Management

Livestock grazing
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD North 12-16 PZ (North Exposure)

32—Evick-Rock outcrop complex, 30 to 65 percent slopes

Composition

Evick soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 2,200 to 3,200 feet
Native plants: Evick—bluebunch wheatgrass, Idaho fescue, antelope bitterbrush, western juniper, and ponderosa pine
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Evick Soil

0 to 3 inches—very dark brown gravelly loamy sand
3 to 11 inches—very dark brown gravelly loamy sand
11 inches—tuff

Properties and Qualities of the Evick Soil

Depth: Shallow (10 to 14 inches)
Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 14 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Volcanic tuff

Contrasting Inclusions

- Happus soils on concave foot slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Rock outcrop, slope, and aspect

Use and Management

Timber production
- This unit is poorly suited to the production of timber.
- The Evick soil has severe ratings for sheet and rill erosion, cut and fill erosion, equipment limitations, soil displacement, seedling mortality, windthrow hazard, and fire damage. Because of these management concerns, this unit is not suitable for logging.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

33—Fawnspring very gravelly silt loam, 2 to 30 percent slopes

Composition

Fawnspring soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 2,200 to 3,800 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 3 inches—very dark gray very gravelly silt loam
3 to 8 inches—very dark grayish brown very gravelly silty clay loam
8 to 26 inches—dark brown clay
26 to 43 inches—weak red clay
43 inches—sedimentary rock

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 5 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Jorn soils on convex side slopes
- Yawkola soils on concave side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- This soil is subject to a severe compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

34—Glaciers-Rubble land complex, 20 to 80 percent slopes

Composition

Glaciers: 50 percent
Rubble land: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Side slopes of Mt. Jefferson and Olallie Butte
Landform: Mountains
Parent material: Andesite, rhyolite, pyroclastic ashflow, and volcanic ash
Elevation: 5,000 to 10,000 feet
Native plants: Scattered, stunted conifers, shrubs, forbs, and grasses
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Contrasting Inclusions

- Jojo and Piumpsha soils on foot slopes of Rubble land

Major Uses

- Wildlife habitat and recreational rock climbing

35—Grenet very gravelly sandy loam, 12 to 30 percent slopes

Composition

Grenet soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—dark grayish brown very gravelly sandy loam
12 to 36 inches—grayish brown extremely gravelly sandy loam
36 inches—tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Pipp soils on concave side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock

fragments in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

36—Grenet very gravelly sandy loam, 30 to 65 percent slopes

Composition

Grenet soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—dark grayish brown very gravelly sandy loam
12 to 36 inches—grayish brown extremely gravelly sandy loam
36 inches—tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Pipp soils on concave side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. Factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Spoil from excavations is subject to rill and gully erosion and to sloughing.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of high winds because of the restricted rooting depth and high content of rock fragments in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by

logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

37—Grenet-Kusu complex, 0 to 12 percent slopes

Composition

Grenet soil: 50 percent
Kusu soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Grenet—convex benches and side slopes;
Kusu—level and concave benches
Landform: Mountains
Parent material: Residuum and colluvium derived from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile of the Grenet Soil

0 to 12 inches—dark grayish brown very gravelly sandy loam
12 to 36 inches—grayish brown extremely gravelly sandy loam
36 inches—tuff

Properties and Qualities of the Grenet Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Kusu Soil

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 51 inches—dark brown extremely gravelly loam
51 inches—fractured tuff

Properties and Qualities of the Kusu Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Simnasho soils on convex side slopes
- Smiling soils on concave benches
- Pipp soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Grenet and Kusu—seedling mortality and plant competition
- Grenet—windthrow hazard

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment damages the soil less and helps to maintain productivity.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Grenet soil.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres

in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

38—Grenet-Kusu complex, 12 to 30 percent slopes

Composition

Grenet soil: 50 percent
Kusu soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Grenet—convex, south-facing side slopes; Kusu—concave, south-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile of the Grenet Soil

0 to 12 inches—dark grayish brown very gravelly sandy loam
12 to 36 inches—grayish brown extremely gravelly sandy loam
36 inches—tuff

Properties and Qualities of the Grenet Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Kusu Soil

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 51 inches—dark brown extremely gravelly loam
51 inches—fractured tuff

Properties and Qualities of the Kusu Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Smiling soils on concave foot slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Grenet and Kusu—equipment operability, soil displacement, seedling mortality, and plant competition
- Grenet—windthrow hazard
- Kusu—fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Grenet soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate

fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

39—Happus very gravelly sandy loam, 12 to 30 percent slopes

Composition

Happus soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing toe slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 3,200 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 9 inches—dark brown very gravelly sandy loam
9 to 29 inches—brown extremely gravelly sandy loam
29 to 60 inches—light gray fragmental pumice

Soil Properties and Qualities

Depth: Moderately deep to pumice (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Spilyay soils on foot slopes
- Kishwalk soils on nonforested, convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Seepage and soil compaction

Use and Management

Timber production
- This soil is susceptible to raveling because of the coarse texture and limited cohesiveness of the particles.
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Spoil from excavations is subject to rill and gully erosion and to sloughing.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the poor anchoring capability of the pumice.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be

designed carefully to minimize detrimental impacts to the soil.

Livestock grazing

- Pond development on this soil generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

40—Hehe very cobbly loam, 30 to 65 percent slopes

Composition

Hehe soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,000 to 3,300 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:

- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 11 inches—dark brown very cobbly loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Teewee soils on concave side slopes
- Rock outcrop on upper side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production

- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing

- Rock outcrop and slope

Use and Management

Timber production

- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Avoid constructing roads at midslope. Midslope roads are difficult to maintain and require large cuts and fills that remove land from production.
- Spoil from excavations is subject to rill and gully erosion and to sloughing.
- Because of the steepness of slope, logging systems that fully or partially suspend logs generally are less damaging to the soil.
- The Rock outcrop may cause breakage of timber and hinder yarding.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage because of the restricted rooting depth and high content of rock fragments in this soil.

- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

41—Hehe very stony loam, 12 to 40 percent slopes

Composition

Hehe soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Side slopes of drainageways
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,000 to 3,300 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 11 inches—dark brown very stony loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Teewee soils on concave toe slopes
- Rock outcrop on shoulders

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Rock outcrop and soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage

during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

42—Hehe very stony loam, high precipitation, 12 to 40 percent slopes

Composition

Hehe soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Side slopes of drainageways
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine, antelope bitterbrush, greenleaf manzanita, Idaho fescue, and prairie junegrass
Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—45 to 47 degrees F
- Frost-free period—80 to 110 days

Typical Profile

0 to 11 inches—dark brown very stony loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Teewee soils on concave toe slopes
- Rock outcrop on shoulders

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Rock outcrop and soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.

- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in this soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR-ARPA

43—Hehe-Bodell complex, 0 to 12 percent slopes

Composition

Hehe soil: 60 percent
Bodell soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Hehe—convex benches and side slopes; Bodell—scablands
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,600 to 3,300 feet
Native plants: Hehe—ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass; Bodell—onespike oatgrass, Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Hehe Soil

0 to 11 inches—dark brown very stony loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Properties and Qualities of the Hehe Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Bodell Soil

0 to 4 inches—dark brown very stony loam
4 to 14 inches—dark brown extremely cobbly clay loam
14 inches—basalt

Properties and Qualities of the Bodell Soil

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Teewee soils on concave benches

Major Uses

- Hehe and Bodell—livestock grazing and wildlife habitat
- Hehe—timber production

Major Management Limitations

Timber production
- Hehe—equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Hehe and Bodell—soil compaction
- Bodell—depth to bedrock

Use and Management

Timber production

- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Hehe soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Hehe soil.

Livestock grazing

- Pond development on the Bodell soil generally is impractical because of the limited soil depth.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- Hehe—PIPO/PUTR

Range Site

- Bodell—Moist Scabland 14-18 PZ

44—Hehe-Teewee complex, 0 to 12 percent slopes

Composition

Hehe soil: 60 percent
Teewee soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Hehe—convex benches and side slopes; Teewee—level and concave benches
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,600 to 3,300 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:

- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Hehe Soil

0 to 11 inches—dark brown very stony loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Properties and Qualities of the Hehe Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Teewee Soil

0 to 11 inches—dark brown loam
11 to 18 inches—dark brown loam
18 to 43 inches—dark brown clay loam
43 to 53 inches—dark brown very stony clay loam
53 inches—weathered andesite

Properties and Qualities of the Teewee Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: 40 to 60 inches

Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Bodell soils on scablands

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Hehe and Teewee—equipment operability, soil compaction, seedling mortality, and plant competition
- Hehe—fire damage and windthrow hazard

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer of the Hehe soil is subject to a moderate soil compaction hazard because of the texture, and the surface layer of the Teewee soil is subject to a severe soil compaction hazard because of the texture and low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Hehe soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Hehe soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

45—Hehe-Teewee complex, high precipitation, 0 to 12 percent slopes

Composition

Hehe soil: 60 percent
Teewee soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Hehe—convex benches and side slopes; Teewee—level and concave benches
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,500 to 3,500 feet
Native plants: Ponderosa pine (see fig. 11, next page), antelope bitterbrush, greenleaf manzanita, Idaho fescue, and prairie junegrass
Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—45 to 47 degrees F
- Frost-free period—80 to 110 days

Typical Profile of the Hehe Soil

0 to 11 inches—dark brown very stony loam
11 to 19 inches—dark brown very bouldery loam
19 to 38 inches—dark brown very bouldery clay loam
38 inches—weathered andesite

Properties and Qualities of the Hehe Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Figure 11.—Old-growth ponderosa pine in an area of Hehe-Teewee complex, high precipitation, 0 to 12 percent slopes.

Typical Profile of the Teewee Soil

0 to 11 inches—dark brown loam
11 to 18 inches—dark brown loam
18 to 43 inches—dark brown clay loam
43 to 53 inches—dark brown very stony clay loam
53 inches—weathered andesite

Properties and Qualities of the Teewee Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Bodell soils on scablands

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Hehe and Teewee—equipment operability, soil compaction, seedling mortality, and plant competition
- Hehe—fire damage and windthrow hazard

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer of the Hehe soil is subject to a moderate soil compaction hazard because of the texture, and the surface layer of the Teewee soil is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Hehe soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Hehe soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR-ARPA

46—Howash very cobbly sandy loam, cool, 12 to 30 percent slopes

Composition

Howash soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 4,000 to 5,600 feet
Native plants: Grand fir, lodgepole pine, Douglas fir, pachystima, pinegrass, and big huckleberry
Climatic factors:
- Mean annual precipitation—50 to 70 inches
- Mean annual air temperature—38 to 40 degrees F
- Frost-free period—30 to 60 days

Typical Profile

0 to 11 inches—very dark grayish brown very cobbly sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Kutcher soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, and plant competition

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with logging slash and brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR-PICO/PAMY/CARU

47—Howash very cobbly sandy loam, cool, 30 to 65 percent slopes

Composition

Howash soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains

Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 4,000 to 5,600 feet
Native plants: Grand fir, lodgepole pine, Douglas fir, pachystima, pinegrass, and big huckleberry
Climatic factors:
- Mean annual precipitation—50 to 70 inches
- Mean annual air temperature—38 to 40 degrees F
- Frost-free period—30 to 60 days

Typical Profile

0 to 11 inches—very dark grayish brown very cobbly sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kutcher soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Erosion hazard, equipment operability, soil displacement, and plant competition

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR-PICO/PAMY/CARU

48—Howash very cobbly sandy loam, low precipitation, 12 to 30 percent slopes

Composition

Howash soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 5,000 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile

0 to 11 inches—very dark grayish brown very cobbly sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid

Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Kutcher soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, and plant competition

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

49—Howash very cobbly sandy loam, low precipitation, 30 to 65 percent slopes

Composition

Howash soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,000 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile

0 to 11 inches—very dark grayish brown very cobbly sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kutcher soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Erosion hazard, equipment operability, soil displacement, and plant competition

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited (see fig. 12, next page).
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.

• Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Figure 12.—High-lead logging in an area of Howash very cobbly sandy loam, low precipitation, 30 to 65 percent slopes. Area of Pipp very stony sandy loam, 30 to 65 percent slopes, on south-facing side slopes in background.

Wildlife habitat

• Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
• Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
• Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

• ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

50—Howash very gravelly sandy loam, 12 to 30 percent slopes

Composition

Howash soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 4,800 feet
Native plants: Pacific silver fir, western hemlock, Douglas fir, queencup beadlily, vine maple, big huckleberry, and golden chinkapin
Climatic factors:
• Mean annual precipitation—60 to 90 inches
• Mean annual air temperature—40 to 42 degrees F
• Frost-free period—40 to 90 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 48 inches—brown very gravelly and very cobbly sandy loam
48 to 60 inches—dark yellowish brown extremely cobbly loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

• Kutcher soils on convex side slopes
• Mackatie soils on benches and concave foot slopes

Major Uses

• Timber production and wildlife habitat

Major Management Limitations

Timber production

• Equipment operability, soil displacement, and plant competition

Use and Management

Timber production

• Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
• Logging may be restricted during November through April because of soil wetness.
• Using machinery only in areas covered with slash or brush reduces soil displacement.

• Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
• Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
• Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
• Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

• ABAM/CLUN and TSHE/ACCI

51—Howash very gravelly sandy loam, 30 to 65 percent slopes

Composition

Howash soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 4,800 feet
Native plants: Pacific silver fir, western hemlock, Douglas fir, queencup beadlily, vine maple, big huckleberry, and golden chinkapin
Climatic factors:
• Mean annual precipitation—60 to 90 inches
• Mean annual air temperature—40 to 42 degrees F
• Frost-free period—40 to 90 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 48 inches—brown very gravelly and very cobbly sandy loam
48 to 60 inches—dark yellowish brown extremely cobbly loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

• Kutcher soils on convex side slopes
• Mackatie soils on concave foot slopes

Major Uses

• Timber production and wildlife habitat

Major Management Limitations

Timber production
• Erosion hazard, equipment operability, soil displacement, and plant competition

Use and Management

Timber production
• Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
• Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
• Logging may be restricted during November through April because of soil wetness.
• Using machinery only in areas covered with slash or brush reduces soil displacement.
• Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
• Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
• Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
• Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABAM/CLUN and TSHE-ACCI

52—Howash very stony sandy loam, low precipitation, 12 to 30 percent slopes

Composition

Howash soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,000 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile

0 to 11 inches—very dark grayish brown very stony sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Kutcher soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, plant competition, and fire damage

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and the rmal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

53—Howash very stony sandy loam, low precipitation, 30 to 65 percent slopes

Composition

Howash soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,000 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile

0 to 11 inches—very dark grayish brown very stony sandy loam
11 to 42 inches—brown very cobbly sandy loam
42 to 60 inches—dark yellowish brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kutcher soils on convex side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Erosion hazard, equipment operability, soil displacement, plant competition, and fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Rock outcrop may cause breakage of timber and hinder yarding.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

54—Jojo-Pinhead complex, warm, 30 to 65 percent slopes

Composition

Jojo soil: 60 percent
Pinhead soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Jojo—convex side slopes; Pinhead—concave side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,000 to 5,600 feet
Native plants: Pacific silver fir, lodgepole pine, western hemlock, Douglas fir, western white pine, common beargrass, and big huckleberry

Climatic factors:
- Mean annual precipitation—70 to 100 inches
- Mean annual air temperature—36 to 38 degrees F
- Frost-free period—20 to 45 days

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 32 inches—reddish brown very gravelly and extremely gravelly sandy loam and loamy sand
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Pinhead Soil

0 to 18 inches—dark brown very stony sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Properties and Qualities of the Pinhead Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Jojo and Pinhead—soil erosion, equipment operability, soil displacement, seedling mortality, plant competition, and fire damage
- Jojo—windthrow hazard

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Rock outcrop may cause breakage of timber and hinder yarding.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to severe windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Jojo soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABAM/XETE

55—Jojo-Piumpsha-Pinhead complex, 2 to 40 percent slopes, bouldery

Composition

Jojo soil: 40 percent
Piumpsha soil: 25 percent
Pinhead soil: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Jojo—shoulders and convex side slopes; Piumpsha—benches and concave side slopes; Pinhead—concave side slopes and foot slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,800 to 6,400 feet
Native plants: Mountain hemlock, lodgepole pine, western white pine, subalpine fir, big huckleberry, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very bouldery sandy loam
7 to 32 inches—reddish brown very gravelly and extremely gravelly sandy loam and loamy sand
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Piumpsha Soil

0 to 8 inches—very dark brown very bouldery sandy loam
8 to 27 inches—dark yellowish brown gravelly sandy loam
27 to 60 inches—dark brown gravelly clay loam

Properties and Qualities of the Piumpsha Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 8 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Pinhead Soil

0 to 18 inches—dark brown very bouldery sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Properties and Qualities of the Pinhead Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Typic Vitricryands and Rubble land

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Jojo, Piumpsha, and Pinhead—equipment operability, soil displacement, seedling mortality, windthrow hazard, and plant competition
- Jojo and Pinhead—fire damage
- Piumpsha—soil compaction

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones and boulders on the surface can cause breakage of timber and interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Piumpsha soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Cold winds and frost heaving may increase seedling mortality.
- The seedling mortality rate on the Jojo soil may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Jojo soil make planting of bare-root tree seedlings difficult and reduce seedling survival.

- Trees are subject to moderate or severe windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soils.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME-PICO-ABLA2 and TSME-PICO/ARNE

56—Jojo-Rock outcrop complex, 30 to 70 percent slopes

Composition

Jojo soil: 55 percent
Rock outcrop: 30 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,200 to 6,400 feet
Native plants: Mountain hemlock, lodgepole pine, subalpine fir, big huckleberry, western white pine, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 32 inches—reddish brown very gravelly sandy loam
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Andesite

Contrasting Inclusions

- Pinhead soils on foot slopes
- Piumpsha soils on adjacent benches

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Rock outcrop may cause breakage of timber and hinder yarding.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Cold winds and frost heaving may increase seedling mortality.

- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to severe windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat

- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME/XETE, TSME-PICO/ARNE, TSME-PICO/VASC, and TSME-PICO-ALBA2

57—Jorn-Bodell complex, 30 to 55 percent slopes

Composition

Jorn soil: 50 percent
Bodell soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Jorn—concave, south-facing side slopes; Bodell—convex, south-facing side slopes
Landform: Mountains
Parent material: Jorn—residuum and colluvium derived from sedimentary rock with an influence of volcanic ash; Bodell—residuum and colluvium derived from basalt with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Jorn—ponderosa pine, Douglas fir, Oregon white oak, antelope bitterbrush, and Idaho fescue; Bodell—bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and antelope bitterbrush
Climatic factors:

- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Jorn Soil

0 to 5 inches—very dark brown cobbly silt loam
5 to 12 inches—very dark grayish brown gravelly silty clay loam
12 to 21 inches—dark brown gravelly silty clay
21 to 24 inches—dark brown gravelly silty clay
24 inches—sedimentary rock

Properties and Qualities of the Jorn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Bodell Soil

0 to 4 inches—dark brown very cobbly loam
4 to 14 inches—dark brown very gravelly loam and extremely gravelly clay loam
14 inches—basalt

Properties and Qualities of the Bodell Soil

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Yawkola soils on concave side slopes
- Kaskela soils on nonforested foot slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production

- Jorn—soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire hazard

Livestock grazing

- Jorn and Bodell—slope, aspect, and soil compaction

Use and Management

Timber production

- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soils are disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging roads for year-round use require heavy base rock.
- This unit is subject to a moderate soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soils are dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth of the Jorn soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soils.

Livestock grazing

- Steep slopes may adversely affect livestock distribution.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- Jorn—PIPO-PSME/PUTR (Mutton)

Range Site

- Bodell—Shallow Slopes 14-20 PZ

58—Kaskela complex, 0 to 8 percent slopes

Composition

Kaskela clay: 40 percent
Kaskela cobbly clay: 40 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Benches
Landform: Foothills
Parent material: Residuum and colluvium derived dominantly from sedimentary rock
Elevation: 2,400 to 3,400 feet
Native plants: Basin wildrye, bluebunch wheatgrass, antelope bitterbrush, and rose
Climatic factors:

- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 4 inches—dark brown clay and cobbly clay
4 to 31 inches—dark reddish brown clay
31 to 42 inches—reddish brown clay loam
42 inches—sedimentary rock

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: 40 to 60 inches

Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Prill soils on convex positions of benches
- Dahl soils in adjacent drainageways

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Shrink-swell potential, surface cobbles, and soil compaction

Use and Management

Livestock grazing
- If this soil is seeded, use plants that tolerate the high shrink-swell potential.
- Range seeding with ground equipment may be impractical in some areas of this unit because of the cobbles on the surface.
- Seeding the more favorable areas of this unit is difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat
- On critical range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Clayey Bottom

59—Kishwalk very cobbly silt loam, 55 to 80 percent slopes

Composition

Kishwalk soil: 75 percent
Contrasting inclusion: 25 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Colluvium derived dominantly from basalt with an influence of loess in the upper part
Elevation: 1,800 to 3,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 14 inches—very dark brown very cobbly silt loam
14 to 31 inches—very dark grayish brown very stony and extremely stony clay loam
31 to 38 inches—brown extremely stony clay
38 inches—basalt

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Very rapid
Hazard of erosion: Severe

Contrasting Inclusions

- Sagley soils on concave side slopes
- Waterbury soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Slope and surface cobbles

Use and Management

Livestock grazing
- Steep slopes and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD North 12-16 PZ (North Exposure)

60—Kishwalk-Waterbury complex, 30 to 55 percent slopes

Composition

Kishwalk soil: 50 percent
Waterbury soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Kishwalk—concave, south-facing side slopes; Waterbury—convex, south-facing side slopes
Landform: Canyons
Parent material: Colluvium derived from basalt and rhyolite
Elevation: 1,800 to 3,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Kishwalk Soil

0 to 14 inches—very dark brown very stony loam
14 to 31 inches—very dark grayish brown very stony and extremely stony clay loam
31 to 38 inches—brown extremely stony clay
38 inches—basalt

Properties and Qualities of the Kishwalk Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 7 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Waterbury Soil

0 to 3 inches—very dark brown extremely stony loam
3 to 8 inches—very dark brown very stony clay loam
8 to 16 inches—dark brown extremely stony clay
16 inches—basalt

Properties and Qualities of the Waterbury Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kaskela soils on foot slopes
- Prill soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, surface stones, slope, and aspect

Use and Management

Livestock grazing
- Low annual precipitation and the shallow rooting depth of the Waterbury soil limit the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and stones on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Clayey South 12-16 PZ (South Exposure)

61—Kuckup gravelly sandy loam, 15 to 40 percent slopes

Composition

Kuckup soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Side slopes
Landform: Cinder cones
Parent material: Volcanic ash and cinders
Elevation: 3,800 to 6,100 feet
Native plants: Mountain hemlock, lodgepole pine, big huckleberry, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile

0 to 6 inches—dark brown gravelly sandy loam

6 to 29 inches—dark reddish brown gravelly sandy loam
29 to 60 inches—reddish brown cinders

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 5 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid
Hazard of erosion: High

Contrasting Inclusions

- Jojo soils on convex foot slopes
- Pinhead soils on concave foot slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, plant competition, and fire damage

Use and Management

Timber production
- This soil is susceptible to ravel erosion because of the coarse texture and limited cohesiveness of the particles.
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the poor anchoring capability of the cinders.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME/XETE and TSME-PICO/VASC

62—Kusu very gravelly loam, 2 to 30 percent slopes

Composition

Kusu soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 3,800 to 4,500 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush ceanothus, greenleaf manzanita, western fescue, and tailcup lupine
Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—80 to 110 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly loam
14 to 51 inches—dark brown very gravelly sandy loam
51 inches—fractured tuff

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Peahke soils on convex side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Seepage and soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- The surface layer has a moderate compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.
- Pond development on this soil generally is impractical because of the risk of seepage.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/ARPA-CEVE (Mutton)

63—Kusu very gravelly loam, 30 to 55 percent slopes

Composition

Kusu soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 3,800 to 4,500 feet
Native plants: Ponderosa pine, Douglas fir, snowbrush ceanothus, greenleaf manzanita, western fescue, and tailcup lupine
Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—80 to 110 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly loam
14 to 51 inches—dark brown very gravelly sandy loam
51 inches—fractured tuff

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Peahke soils on convex side slopes
- Rock outcrop on upper side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, and plant competition

Livestock grazing
- Slope and soil compaction

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- The surface layer has a moderate compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Livestock grazing
- Steep slope may adversely affect livestock distribution.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/ARPA-CEVE (Mutton)

64—Kusu very gravelly sandy loam, 12 to 30 percent slopes

Composition

Kusu soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 51 inches—dark brown extremely gravelly loam
51 inches—fractured tuff

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Grenet soils on convex side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, and plant competition

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire or some other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

65—Kusu very gravelly sandy loam, 30 to 65 percent slopes

Composition

Kusu soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff and volcanic ash
Elevation: 2,800 to 4,600 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 14 inches—very dark grayish brown very gravelly sandy loam
14 to 51 inches—dark brown extremely gravelly loam
51 inches—fractured tuff

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: 3 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Grenet soils on convex side slopes
- Rock outcrop on convex, upper side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil displacement, and plant competition

Use and Management

Timber production

- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/CEVE and MIXED CONIFER/SYMPH

66—Kutcher-Mackatie complex, low precipitation, 12 to 30 percent slopes

Composition

Kutcher soil: 50 percent
Mackatie soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Kutcher—convex side slopes; Mackatie—benches and concave side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 3,000 to 5,400 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:

- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile of the Kutcher Soil

0 to 18 inches—dark brown very cobbly sandy loam
18 to 38 inches—brown extremely cobbly clay loam
38 inches—weathered andesite

Properties and Qualities of the Kutcher Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Mackatie Soil

0 to 18 inches—dark brown sandy loam
18 to 41 inches—dark brown loam and clay loam
41 to 51 inches—brown extremely cobbly clay loam
51 inches—weathered andesite

Properties and Qualities of the Mackatie Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Howash soils on convex benches and side slopes
- Rock outcrop on shoulders

Major Uses

- Timber production, wildlife habitat, and watershed

Major Management Limitations

Timber production

- Kutcher and Mackatie—equipment operability, soil displacement, and plant competition
- Kutcher—windthrow
- Mackatie—soil compaction

Use and Management

Timber production

- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Mackatie soil is subject to a moderate soil compaction hazard because of the low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Kutcher soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

67—Lavey gravelly silt loam, 2 to 15 percent slopes

Composition

Lavey soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landform: Low foothills
Parent material: Loess over colluvium derived from sedimentary rock or tuff
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 5 inches—dark brown gravelly silt loam
5 to 21 inches—dark grayish brown clay
21 to 25 inches—dark grayish brown silty clay loam
25 to 28 inches—weathered tuff
28 inches—welded tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Skoven soils on scablands
- Day soils on foot slopes

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing

- Droughtiness and soil compaction

Use and Management

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Droughty Loam 8-10 PZ (Arid Rolling Hills)

68—Lavey very cobbly silty clay loam, 2 to 15 percent slopes

Composition

Lavey soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landform: Low foothills
Parent material: Loess over colluvium derived from sedimentary rock or tuff
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 5 inches—dark brown very cobbly silty clay loam
5 to 21 inches—dark grayish brown clay
21 to 25 inches—dark grayish brown silty clay loam
25 to 28 inches—weathered tuff
28 inches—welded tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Skoven soils on scablands
- Day soils on foot slopes

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing
- Droughtiness and surface cobbles

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the cobbles on the surface.

Range Site

- Droughty Loam 8-10 PZ (Arid Rolling Hills)

69—Lickskillet extremely stony loam, 15 to 40 percent slopes

Composition

Lickskillet soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt
Elevation: 1,200 to 3,200 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, Wyoming big sagebrush, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 9 inches—very dark brown extremely stony loam
9 to 18 inches—dark brown extremely stony clay loam
18 inches—basalt

Soil Properties and Qualities

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 12 to 20 inches
Runoff: Rapid
Hazard of erosion: High

Contrasting Inclusions

- Ruclick soils on foot slopes
- Ruckles soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness and surface stones

Use and Management

Livestock grazing
- Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.

• Range seeding with ground equipment is impractical because of the stones on the surface.

Wildlife habitat
• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• Droughty South 9-12 PZ (Droughty South Exposure)

70—Lickskillet extremely stony loam, 40 to 70 percent slopes

Composition

Lickskillet soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt
Elevation: 1,200 to 3,200 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, Wyoming big sagebrush, western juniper, and antelope bitterbrush
Climatic factors:
• Mean annual precipitation—9 to 12 inches
• Mean annual air temperature—50 to 52 degrees F
• Frost-free period—110 to 160 days

Typical Profile

0 to 9 inches—very dark brown extremely stony loam
9 to 18 inches—dark brown extremely stony clay loam
18 inches—basalt

Soil Properties and Qualities

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 12 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

• Ruclick soils on foot slopes
• Ruckles soils on foot slopes
• Rock outcrop on upper, convex side slopes

Major Uses

• Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
• Droughtiness, surface stones, slope, and aspect

Use and Management

Livestock grazing
• Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.
• Steep slopes and stones on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
• Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• Droughty South 9-12 PZ (Droughty South Exposure)

71—Littlefawn-Fawnspring complex, 2 to 30 percent slopes

Composition

Littlefawn soil: 50 percent
Fawnspring soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Littlefawn—convex benches and north-facing side slopes; Fawnspring—concave benches and drainageways
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of volcanic ash
Elevation: 2,200 to 3,800 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
• Mean annual precipitation—16 to 20 inches
• Mean annual air temperature—45 to 49 degrees F
• Frost-free period—90 to 120 days

Typical Profile of the Littlefawn Soil

0 to 10 inches—dark brown gravelly loam
10 to 17 inches—dark brown gravelly loam
17 to 22 inches—brown gravelly silty clay loam
22 to 32 inches—dark reddish brown gravelly clay
32 inches—sedimentary rock

Properties and Qualities of the Littlefawn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Fawnspring Soil

0 to 3 inches—very dark gray very gravelly silt loam
3 to 8 inches—very dark grayish brown very gravelly silty clay loam
8 to 26 inches—dark brown clay
26 to 43 inches—weak red clay
43 inches—sedimentary rock

Properties and Qualities of the Fawnspring Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 5 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Boardflower soils on concave benches
- Mutton soils on north-facing side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Littlefawn and Fawnspring—equipment operability, soil compaction, seedling mortality, windthrow hazard, and plant competition
- Littlefawn—soil erosion
- Fawnspring—soil displacement

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- This unit is subject to a moderate soil compaction hazard because of the texture of the surface layer.
- Restrict the use of equipment to periods when the soils are dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement on the Fawnspring soil.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soils.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

72—Littlefawn-Wakamo-Fawnspring complex, 2 to 30 percent slopes

Composition

Littlefawn soil: 40 percent
Wakamo soil: 25 percent
Fawnspring soil: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Littlefawn—concave benches and side slopes; Wakamo—convex benches and side slopes; Fawnspring—concave foot slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Littlefawn Soil

0 to 10 inches—dark brown gravelly loam
10 to 17 inches—dark brown gravelly loam
17 to 22 inches—brown gravelly silty clay loam
22 to 32 inches—dark reddish brown gravelly clay
32 inches—sedimentary rock

Properties and Qualities of the Littlefawn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Wakamo Soil

0 to 11 inches—dark brown very gravelly loam
11 to 15 inches—dark brown extremely gravelly clay loam
15 to 18 inches—dark brown extremely gravelly clay
18 inches—fractured sedimentary rock

Properties and Qualities of the Wakamo Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Fawnspring Soil

0 to 3 inches—very dark gray very gravelly silt loam
3 to 8 inches—very dark grayish brown very gravelly silty clay loam
8 to 26 inches—dark brown clay
26 to 43 inches—weak red clay
43 inches—sedimentary rock

Properties and Qualities of the Fawnspring Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 5 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Logsprings soils in depressional areas

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, and plant competition

Livestock grazing
- Littlefawn, Wakamo, Fawnspring—soil compaction
- Wakamo—depth to bedrock

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the

more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- This unit has a moderate or severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soils are dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement on the Fawnspring soil.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soils.
- Trees are subject to moderate or severe windthrow damage during periods of strong winds because of the restricted rooting depth.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Pond development on the Wakamo soil generally is impractical because of the limited soil depth.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

73—Logsprings loam, 0 to 8 percent slopes

Composition

Logsprings soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Concave benches
Landform: Foothills
Parent material: Alluvium and colluvium over residuum derived dominantly from sedimentary rock with an influence of volcanic ash in the upper part
Elevation: 2,600 to 2,800 feet
Native plants: Ponderosa pine, antelope bitterbrush, mule's-ear, and prairie smoke
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 10 inches—dark grayish brown loam
10 to 21 inches—brown loam
21 to 30 inches—dark brown clay
30 to 36 inches—dark brown extremely gravelly sandy clay loam
36 to 64 inches—dark brown loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Permeability: Slow
Available water capacity: 8 to 13 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Teewee soils on convex benches
- Bodell soils on convex scablands

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.

- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- This soil is subject to a moderate soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

74—Mackatie-Kutcher complex, 0 to 12 percent slopes

Composition

Mackatie soil: 50 percent
Kutcher soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Mackatie—level and concave benches; Kutcher—convex benches and side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 3,400 to 4,800 feet
Native plants: Pacific silver fir, western hemlock, Douglas fir, queencup beadlily, vine maple, big huckleberry, and golden chinkapin
Climatic factors:
- Mean annual precipitation—60 to 90 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—40 to 90 days

Typical Profile of the Mackatie Soil

0 to 18 inches—dark brown sandy loam
18 to 41 inches—dark brown loam and clay loam
41 to 51 inches—brown extremely cobbly clay loam
51 inches—weathered andesite

Properties and Qualities of the Mackatie Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Kutcher Soil

0 to 18 inches—dark brown very cobbly sandy loam
18 to 38 inches—brown extremely cobbly clay loam
38 inches—weathered andesite

Properties and Qualities of the Kutcher Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Howash soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Mackatie and Kutcher—plant competition
- Mackatie—soil compaction and soil displacement
- Kutcher—windthrow hazard

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.

- The surface layer of the Mackatie soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement on the Mackatie soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Kutcher soil (fig. 13).
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 8 to 10 years after the canopy has been opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSHE/ACCI and ABAM/CLUN

75—Mackatie-Kutcher complex, cool, 0 to 12 percent slopes

Composition

Mackatie soil: 50 percent
Kutcher soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Mackatie—level and concave benches;
Kutcher—convex benches and side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 4,700 to 5,600 feet
Native plants: Grand fir, lodgepole pine, Douglas fir, pachystima, pinegrass, and big huckleberry
Climatic factors:
- Mean annual precipitation—50 to 70 inches
- Mean annual air temperature—38 to 40 degrees F
- Frost-free period—30 to 60 days

Typical Profile of the Mackatie Soil

0 to 18 inches—dark brown sandy loam
18 to 41 inches—dark brown loam and clay loam
41 to 51 inches—brown extremely cobbly clay loam
51 inches—weathered andesite

Figure 13.—Windthrow damage on the Kutcher soil in an area of Mackatie-Kutcher complex, 0 to 12 percent slopes.

Properties and Qualities of the Mackatie Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Kutcher Soil

0 to 18 inches—dark brown very cobbly sandy loam
18 to 38 inches—brown extremely cobbly clay loam
38 inches—weathered andesite

Properties and Qualities of the Kutcher Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow

Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Howash soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Mackatie and Kutcher—plant competition
- Mackatie—soil compaction and soil displacement
- Kutcher—windthrow hazard

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Mackatie soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement on the Mackatie soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Kutcher soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, and trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR-PICO/PAMY CARU

76—Mackatie-Kutcher complex, low precipitation, 0 to 12 percent slopes

Composition

Mackatie soil: 50 percent
Kutcher soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Mackatie—level and concave benches; Kutcher—convex benches and side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 3,000 to 4,700 feet
Native plants: Grand fir, Douglas fir, ponderosa pine, pachystima, common snowberry, and vine maple
Climatic factors:
- Mean annual precipitation—40 to 60 inches
- Mean annual air temperature—40 to 42 degrees F
- Frost-free period—50 to 80 days

Typical Profile of the Mackatie Soil

0 to 18 inches—dark brown sandy loam
18 to 41 inches—dark brown loam and clay loam
41 to 51 inches—brown extremely cobbly clay loam
51 inches—weathered andesite

Properties and Qualities of the Mackatie Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Kutcher Soil

0 to 18 inches—dark brown very cobbly sandy loam
18 to 38 inches—brown extremely cobbly clay loam
38 inches—weathered andesite

Properties and Qualities of the Kutcher Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Howash soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Mackatie and Kutcher—plant competition
- Mackatie—soil compaction and soil displacement
- Kutcher—windthrow hazard

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Mackatie soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement on the Mackatie soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Kutcher soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, and trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABGR/PAMY, ABGR/SYMPH, and ABGR/ACCI

77—Madras loam, 0 to 8 percent slopes

Composition

Madras soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landform: Low foothills
Parent material: Loess over colluvium derived from sedimentary rock or tuff
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 10 inches—very dark grayish brown loam
10 to 33 inches—dark brown clay loam
33 to 35 inches—weathered tuff
35 inches—welded tuff

Soil Properties and Qualities

Depth: Moderately deep (22 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 7 inches

Potential rooting depth: 22 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Skoven soils on scablands
- Lavey soils on mounds

Major Uses

- Cropland (fig. 14) and livestock grazing

Figure 14.—Alfalfa hay on Madras loam, 0 to 8 percent slopes. Ruckles-Simas-Rock outcrop complex, 40 to 80 percent slopes, on canyonsides in background.

Major Management Limitations

Cropland

- Droughtiness, permeability, soil compaction, slope, and depth to bedrock

Livestock grazing

- Droughtiness and soil compaction

Use and Management

Cropland

- Low annual precipitation restricts annual cropping unless supplemental irrigation is used.
- Because of the moderately slow permeability rate of the subsoil, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.
- The loam surface layer is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.
- Care should be taken when using surface irrigation on slopes of more than 3 percent.

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Droughty Loam 8-10 PZ (Arid Rolling Hills)

78—Madras-Skoven complex, 0 to 8 percent slopes

Composition

Madras soil: 55 percent
Skoven soil: 35 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Madras—mounds of patterned ground; Skoven—scablands of patterned ground
Landform: Low foothills
Parent material: Loess over colluvium derived from sedimentary rock or tuff
Elevation: 1,400 to 2,400 feet
Native plants: Madras—bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper; Skoven—Sandberg bluegrass, buckwheat, bluebunch wheatgrass, lomatium, and squirreltail
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Madras Soil

0 to 10 inches—very dark grayish brown loam
10 to 33 inches—dark brown clay loam
33 to 35 inches—weathered tuff
35 inches—welded tuff

Properties and Qualities of the Madras Soil

Depth: Moderately deep (22 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 7 inches
Potential rooting depth: 22 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Skoven Soil

0 to 3 inches—very dark grayish brown extremely gravelly silt loam
3 to 8 inches—dark brown very gravelly silty clay loam
8 to 11 inches—reddish brown extremely gravelly clay
11 to 21 inches—weathered tuff
21 inches—welded tuff

Properties and Qualities of the Skoven Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Lavey soils on mounds

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing
- Madras and Skoven—droughtiness
- Madras—soil compaction
- Skoven—depth to bedrock

Use and Management

Livestock grazing
- Pond development on the Skoven soil generally is impractical because of the limited soil depth.
- Low annual precipitation and the shallow rooting depth of the Skoven soil limit the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants on the Madras soil.

Range Site

- Madras—Droughty Loam 8-10 PZ (Arid Rolling Hills)
- Skoven—Buckwheat Scabland 9-12 PZ

79—Mariel mucky peat, 0 to 3 percent slopes

Composition

Mariel soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Mountain bogs
Parent material: Organic material from water-tolerant plants
Elevation: 3,000 to 5,000 feet
Native plants: Rushes, sedges, and tufted hairgrass
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile

0 to 14 inches—black mucky peat
14 to 34 inches—very dark gray hemic material
34 to 60 inches—very dark brown sapric material

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Permeability: Rapid
Available water capacity: 15 to 18 inches
Potential rooting depth: 60 inches or more for water-tolerant plants
Runoff: Ponded
Hazard of erosion: None
Depth to water table: 24 inches above the surface to 6 inches below the surface throughout the year
Frequency of flooding: Occasional

Contrasting Inclusions

- Racing soils along the edge of bogs

Major Uses

- Wetland wildlife habitat and livestock grazing

Major Management Limitations

Livestock grazing
- High water table, season of use, and soil compaction

Use and Management

Livestock grazing
- If this unit is seeded, select plants that tolerate seasonal wetness.
- The cold climate and soil temperature delay early growth of forage and shorten the growing season.
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Sedge Meadow

80—Maupin silt loam, 0 to 8 percent slopes

Composition

Maupin soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Nearly level to moderately sloping benches
Landform: Mesas
Parent material: Loess
Elevation: 2,000 to 2,400 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 7 inches—very dark grayish brown silt loam
7 to 20 inches—dark brown silt loam
20 to 25 inches—brown gravelly loam
25 to 31 inches—indurated duripan
31 inches—basalt

Soil Properties and Qualities

Depth: Moderately deep to a duripan (20 to 40 inches); moderately deep to bedrock (25 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 3 to 6 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Bakeoven soils on scablands

Major Uses

- Cropland, livestock grazing, and wildlife habitat

Major Management Limitations

Cropland
- Droughtiness, soil compaction, slope, and depth to duripan

Livestock grazing
- Seepage and droughtiness

Use and Management

Cropland
- Low annual precipitation restricts annual cropping unless supplemental irrigation is used.
- Because of the depth to the duripan, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.
- The silt loam surface layer is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.
- Care should be taken when using surface irrigation on slopes of more than 3 percent.

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause severe soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty Loam 8-10 PZ (Arid Rolling Hills)

81—Milldam-Tenwalter complex, 0 to 3 percent slopes

Composition

Milldam soil: 65 percent
Tenwalter soil: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Milldam—mounds of patterned ground; Tenwalter—scablands of patterned ground
Landform: Outwash plains
Parent material: Residuum derived from glacial outwash with an influence of loess in the upper part
Elevation: 2,600 to 3,000 feet
Native plants: Milldam—Idaho fescue, bluebunch

wheatgrass, antelope bitterbrush, Sandberg bluegrass, and buckwheat; Tenwalter—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail

Climatic factors:

- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Milldam Soil

0 to 10 inches—very dark brown silt loam
10 to 34 inches—dark brown silty clay loam
34 to 37 inches—brown cobbly clay
37 to 51 inches—duripan
51 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Milldam Soil

Depth: Moderately deep to a duripan (30 to 40 inches); very deep to bedrock (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 30 to 40 inches
Runoff: Slow
Hazard of erosion: Slight

Typical Profile of the Tenwalter Soil

0 to 11 inches—very dark grayish brown very cobbly silt loam
11 to 15 inches—dark brown extremely cobbly clay
15 to 27 inches—duripan
27 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Tenwalter Soil

Depth: Shallow to a duripan (10 to 20 inches); very deep to bedrock (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 3 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Wapinitia soils on large mounds
- Kahneeta soils in concave drainageways

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Milldam and Tenwalter—soil compaction
- Tenwalter—surface cobbles and depth to duripan

Use and Management

Livestock grazing

- Pond development on the Tenwalter soil generally is impractical because of the limited soil depth.
- Range seeding with ground equipment is impractical because of the cobbles on the surface of the Tenwalter soil.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Some areas of this unit provide critical winter range for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Milldam—Shrubby Loam 12-16 PZ (Juniper Rolling Hills)
- Tenwalter—Very Shallow 14-18 PZ

82—Millerflat loam, 0 to 3 percent slopes

Composition

Millerflat soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landform: Stream terraces
Parent material: Alluvium derived from mixed sources with an influence of volcanic ash
Elevation: 2,600 to 3,200 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, common snowberry, golden chinkapin, snowbrush ceanothus, and starflower

Climatic factors:

- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 22 inches—very dark brown loam
22 to 35 inches—dark brown loam
35 to 60 inches—brown extremely gravelly sandy clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Permeability: Moderately slow
Available water capacity: 6 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Vitrandic Haploxerolls along stream channels

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, and plant competition

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer is subject to a severe soil compaction hazard because of the texture and the low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- To reduce siltation and maintain temperatures of streams, areas of this soil adjacent to perennial streams may need to be maintained as buffers.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/SYMPH

83—Mowako extremely channery loam, 30 to 55 percent slopes

Composition

Mowako soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 1,800 to 4,200 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 9 inches—very dark brown extremely channery loam
9 to 27 inches—dark brown extremely channery loam
27 inches—fractured sedimentary rock

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Rock outcrop on shoulders and convex side slopes
- Oldsferry soils on nonforested side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Rock outcrop, slope, and aspect

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Roads and landings can be protected from erosion by applying mulch or seeding cuts and fills.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Rock outcrop may cause breakage of timber and hinder yarding.
- The surface layer is subject to a moderate soil compaction hazard because of the content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- To compensate for the expected high mortality rate, plant larger seedlings or a higher number of seedlings.
- The seedling mortality rate can be reduced by providing artificial shade for seedlings or by leaving some larger trees to provide shade, or both.
- Mulching around seedlings helps to retain moisture in summer.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in this soil.
- Unless the site is adequately prepared immediately after harvest, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR (Mutton)

84—Mowako-Rock outcrop complex, 55 to 80 percent slopes

Composition

Mowako soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 1,800 to 4,200 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Mowako Soil

0 to 9 inches—very dark brown extremely channery loam
9 to 27 inches—dark brown extremely channery loam
27 inches—fractured sedimentary rock

Properties and Qualities of the Mowako Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 20 to 40 inches
Runoff: Very rapid
Hazard of erosion: Very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Oldsferry soils on nonforested side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Rock outcrop, slope, and aspect

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Avoid constructing roads at midslope. Midslope roads require large cuts and fills that remove land from production.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Rock outcrop may cause breakage of timber and hinder yarding.
- The surface layer is subject to a moderate soil compaction hazard because of the content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in this unit.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR (Mutton)

85—Mutton gravelly loam, 12 to 30 percent slopes

Composition

Mutton soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica

Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 8 inches—very dark grayish brown gravelly loam
8 to 17 inches—dark brown gravelly loam
17 to 44 inches—dark brown very gravelly and extremely gravelly loam
44 to 60 inches—brown extremely stony silty clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Boardflower soils on concave benches and side slopes
- Littlefawn soils on convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

86—Mutton gravelly loam, 30 to 55 percent slopes

Composition

Mutton soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 8 inches—very dark grayish brown gravelly loam
8 to 17 inches—dark brown gravelly loam
17 to 44 inches—dark brown very gravelly and extremely gravelly loam
44 to 60 inches—brown extremely stony silty clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Littlefawn soils on convex side slopes
- Eaglespring soils on convex, nonforested side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, and plant competition

Livestock grazing
- Slope and soil compaction

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Steep slopes may adversely affect livestock distribution.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

87—Mutton-Littlefawn complex, 30 to 55 percent slopes

Composition

Mutton soil: 45 percent
Littlefawn soil: 35 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Mutton—north-facing side slopes; Littlefawn—north-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff and sedimentary rock with an influence of volcanic ash
Elevation: 2,200 to 3,800 feet
Native plants: Ponderosa pine, Douglas-fir, Oregon

white oak, common snowberry, and heartleaf arnica

Climatic factors:

- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Mutton Soil

0 to 8 inches—very dark grayish brown gravelly loam
8 to 17 inches—dark brown gravelly loam
17 to 44 inches—dark brown very gravelly and extremely gravelly loam
44 to 60 inches—brown extremely stony silty clay loam

Properties and Qualities of the Mutton Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Littlefawn Soil

0 to 10 inches—dark brown gravelly loam
10 to 17 inches—dark brown gravelly loam
17 to 22 inches—brown gravelly silty clay loam
22 to 32 inches—dark reddish brown gravelly clay
32 inches—sedimentary rock

Properties and Qualities of the Littlefawn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Fawnspring soils in drainageways
- Eaglespring soils on nonforested side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production

- Mutton and Littlefawn—soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, and plant competition
- Littlefawn—windthrow hazard

Livestock grazing

- Slope and soil compaction

Use and Management

Timber production

- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth of the Littlefawn soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing

- Steep slopes may adversely affect livestock distribution.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

• PIPO-PSME/SYMPH (Mutton)

88—Mutton-Rock outcrop complex, 55 to 80 percent slopes

Composition

Mutton soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from tuff with an influence of volcanic ash
Elevation: 1,800 to 3,800 feet
Native plants: Ponderosa pine, Douglas-fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
• Mean annual precipitation—16 to 20 inches
• Mean annual air temperature—45 to 49 degrees F
• Frost-free period—90 to 120 days

Typical Profile of the Mutton Soil

0 to 8 inches—very dark grayish brown gravelly loam
8 to 17 inches—dark brown gravelly loam
17 to 44 inches—dark brown very gravelly and extremely gravelly loam
44 to 60 inches—brown extremely stony silty clay loam

Properties and Qualities of the Mutton Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Very rapid
Hazard of erosion: Very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

• Eaglespring soils on north-facing, nonforested side slopes

Major Uses

• Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
• Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, and plant competition

Livestock grazing
• Slope, Rock outcrop, and soil compaction

Use and Management

Timber production
• Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
• Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
• Avoid constructing roads at midslope. Midslope roads require large cuts and fills that remove land from production.
• Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
• Logging roads for year-round use require heavy base rock.
• Rock outcrop may cause breakage of timber and hinder yarding.
• The surface layer has a severe compaction hazard because of the texture.
• Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
• Use designated skid trails to minimize soil compaction.
• Using machinery only in areas covered with slash or brush reduces soil displacement.
• The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
• Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
• Steep slopes may adversely affect livestock distribution.

• The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
• Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
• Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
• Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
• Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

• PIPO-PSME/SYMPH (Mutton)

89—Olallie clay loam, 0 to 3 percent slopes

Composition

Olallie soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landform: Flood plains
Parent material: Alluvium derived from mixed sources
Elevation: 2,600 to 3,000 feet
Native plants: Tufted hairgrass, bluegrass, sedges, and rushes
Climatic factors:
• Mean annual precipitation—12 to 16 inches
• Mean annual temperature—48 to 50 degrees F
• Frost-free period—100 to 140 days

Typical Profile

0 to 13 inches—black clay loam
13 to 23 inches—very dark brown very gravelly clay loam
23 to 44 inches—dark brown extremely gravelly fine sandy loam
44 to 60 inches—brown extremely gravelly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Poorly drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: More than 60 inches for water-tolerant plants
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: At the surface to 6 inches below the surface in March through June
Frequency of flooding: Rare

Contrasting Inclusions

• Kahneeta soils in depressional areas on adjacent outwash plains
• Millcreek soils in level areas of adjacent outwash plains

Major Uses

• Cropland, livestock grazing, and wildlife habitat

Major Management Limitations

• High water table and soil compaction

Use and Management

Cropland
• Most climatically adapted crops can be grown if artificial drainage is provided.
• In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion.
• The clay loam surface layer is subject to compaction from excessive tillage.
• Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.

Livestock grazing
• If this unit is seeded, select plants that tolerate seasonal wetness.
• Grazing during wet periods can cause soil compaction and damage plants.
• The cold climate and soil temperature delay early growth of forage and shorten the growing season.

Wildlife habitat
• To reduce siltation and maintain temperatures of streams, areas of this soil adjacent to perennial streams may need to be maintained as buffers.

• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• Mountain Meadow (Wet Meadow)

90—Oldsferry-Venator complex, 30 to 55 percent slopes

Composition

Oldsferry soil: 50 percent
Venator soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Oldsferry—concave, south-facing side slopes; Venator—convex, south-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock
Elevation: 1,600 to 4,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
• Mean annual precipitation—12 to 14 inches
• Mean annual air temperature—48 to 50 degrees F
• Frost-free period—100 to 140 days

Typical Profile of the Oldsferry Soil

0 to 12 inches—very dark brown extremely channery loam
12 to 35 inches—dark brown extremely channery loam
35 inches—fractured sedimentary rock

Properties and Qualities of the Oldsferry Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Venator Soil

0 to 4 inches—very dark grayish brown extremely channery loam
4 to 18 inches—dark brown very channery and extremely channery loam
18 inches—fractured sedimentary rock

Properties and Qualities of the Venator Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

• Prill soils on foot slopes
• Rock outcrop on convex side slopes

Major Uses

• Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
• Droughtiness, slope, and aspect

Use and Management

Livestock grazing
• Low annual precipitation and the shallow rooting depth of the Venator soil limit the choice of species for range seeding to drought-tolerant varieties.
• Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
• Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
• On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• JD Clayey South 12-16 PZ (South Exposure)

91—Oldsferry-Venator-Rock outcrop complex, 55 to 80 percent slopes

Composition

Oldsferry soil: 35 percent
Venator soil: 25 percent
Rock outcrop: 25 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Oldsferry—concave, south-facing side slopes; Venator—convex, south-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock
Elevation: 1,600 to 4,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Oldsferry Soil

0 to 12 inches—very dark brown extremely channery loam
12 to 35 inches—dark brown extremely channery loam
35 inches—fractured sedimentary rock

Properties and Qualities of the Oldsferry Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Very rapid
Hazard of erosion: Very high

Typical Profile of the Venator Soil

0 to 4 inches—very dark grayish brown extremely channery loam
4 to 18 inches—dark brown very channery and extremely channery loam
18 inches—fractured sedimentary rock

Properties and Qualities of the Venator Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Very rapid
Hazard of erosion: Very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Prill soils on foot slopes
- Kaskela soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, Rock outcrop, slope, and aspect

Use and Management

Livestock grazing
- Low annual precipitation and the shallow rooting depth of the Venator soil limit the choice of species for range seeding to drought-tolerant varieties.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Clayey South 12-16 PZ (South Exposure)

92—Peahke extremely channery loam, 2 to 30 percent slopes

Composition

Peahke soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 4,000 to 4,500 feet
Native plants: Ponderosa pine, Douglas fir, greenleaf manzanita, snowbrush ceanothus, western fescue, and tailcup lupine

Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—80 to 110 days

Typical Profile

0 to 4 inches—very dark gray extremely channery loam
4 to 32 inches—dark brown extremely channery loam
32 inches—fractured sedimentary rock

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Kusu soils on concave side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Seepage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- The surface layer has a moderate compaction hazard because of the content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments in the soil, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE (Mutton)

93—Peahke extremely channery loam, 30 to 55 percent slopes

Composition

Peahke soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 4,000 to 4,500 feet
Native plants: Ponderosa pine, Douglas fir, greenleaf manzanita, snowbrush ceanothus, western fescue, and tailcup lupine
Climatic factors:
- Mean annual precipitation—20 to 25 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—80 to 110 days

Typical Profile

0 to 4 inches—very dark gray extremely channery loam
4 to 32 inches—dark brown extremely channery loam
32 inches—fractured sedimentary rock

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 3 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Rock outcrop on convex side slopes
- Kusu soils on concave foot slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Slope

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Rock outcrop may cause breakage of timber and hinder yarding.
- The surface layer has a moderate compaction hazard because of the content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments in the soil, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- Steep slopes may adversely affect livestock distribution.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE (Mutton)

94—Pelton-Willowdale complex, 0 to 3 percent slopes

Composition

Pelton soil: 50 percent
Willowdale soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Bars and channels
Landform: Flood plains
Parent material: Alluvium derived from mixed sources
Elevation: 1,100 to 1,600 feet
Native plants: Basin wildrye, bluegrass, slender wheatgrass, and basin big sagebrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Pelton Soil

0 to 4 inches—very dark gray sandy loam
4 to 10 inches—very dark grayish brown gravelly sandy loam
10 to 18 inches—dark brown very gravelly sandy loam
18 to 47 inches—dark brown extremely cobbly sandy clay loam
47 to 60 inches—dark brown extremely cobbly loamy sand

Properties and Qualities of the Pelton Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 4 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: More than 6 feet
Frequency of flooding: Rare

Typical Profile of the Willowdale Soil

0 to 24 inches—very dark grayish brown loam
24 to 48 inches—very dark brown loam
48 to 60 inches—variegated sand and gravel

Properties and Qualities of the Willowdale Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: More than 6 feet
Frequency of flooding: Rare

Contrasting Inclusions

- Pelton very stony sandy loam on alluvial fans
- Riverwash adjacent to channels

Major Uses

- Cropland and livestock grazing

Major Management Limitations

Cropland

- Permeability, leaching, groundwater contamination, and soil compaction

Livestock grazing

- Seepage and soil compaction

Use and Management

Cropland

- Low annual precipitation restricts annual cropping unless supplemental irrigation is used.
- Because of the moderately slow permeability of the subsoil in the Pelton soil, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- Leaching of applied fertilizers and chemicals and groundwater contamination may occur on the Willowdale soil because of the rapid permeability of the substratum.
- The loam surface layer of the Willowdale soil is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.

Livestock grazing

- Pond development generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Loamy Bottom (Moist Bottom)

95—Pinhead very gravelly sandy loam, warm, 0 to 12 percent slopes

Composition

Pinhead soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Broad benches
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 5,300 feet
Native plants: Western hemlock, Pacific silver fir, Douglas fir, western white pine, common beargrass, Pacific rhododendron, and big huckleberry
Climatic factors:

- Mean annual precipitation—70 to 100 inches
- Mean annual air temperature—36 to 38 degrees F
- Frost-free period—20 to 45 days

Typical Profile

0 to 18 inches—dark brown very gravelly sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam

30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Jojo soils on convex benches and gently sloping side slopes
- Pinhead very stony sandy loam on convex benches

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Plant competition

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging may be restricted during November through April because of soil wetness.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSHE/RHMA, TSHE/XETE, and ABAM/XETE

96—Pinhead very gravelly sandy loam, warm, 12 to 30 percent slopes

Composition

Pinhead soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 5,300 feet
Native plants: Western hemlock, Pacific silver fir, Douglas fir, western white pine, common beargrass, Pacific rhododendron, and big huckleberry
Climatic factors:
- Mean annual precipitation—70 to 100 inches
- Mean annual air temperature—36 to 38 degrees F
- Frost-free period—20 to 45 days

Typical Profile

0 to 18 inches—dark brown very gravelly sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Jojo soils on convex side slopes
- Piumpsha soils on concave side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, and plant competition

Use and Management

Timber production

- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 8 to 10 years after the canopy has been opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSHE-XETE and TSHE-RHMA

97—Pinhead very gravelly sandy loam, warm, 30 to 65 percent slopes

Composition

Pinhead soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 3,400 to 5,300 feet
Native plants: Western hemlock, Pacific silver fir, Douglas fir, western white pine, common beargrass, Pacific rhododendron, and big huckleberry
Climatic factors:

- Mean annual precipitation—70 to 100 inches
- Mean annual air temperature—36 to 38 degrees F
- Frost-free period—20 to 45 days

Typical Profile

0 to 18 inches—dark brown very gravelly sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Jojo soils on convex side slopes
- Rock outcrop on shoulders

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production

- Soil erosion, equipment operability, soil displacement, and plant competition

Use and Management

Timber production

- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat

- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least

2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSHE/XETE and TSHE/RHMA

98—Pinhead very stony sandy loam, warm, 12 to 30 percent slopes

Composition

Pinhead soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 4,000 to 5,600 feet
Native plants: Pacific silver fir, mountain hemlock, Douglas fir, western white pine, common beargrass, and big huckleberry.
Climatic factors:
- Mean annual precipitation—70 to 100 inches
- Mean annual air temperature—36 to 38 degrees F
- Frost-free period—20 to 45 days

Typical Profile

0 to 18 inches—dark brown very stony sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Jojo soils on convex side slopes
- Rock outcrop on shoulders

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- ABAM/XETE

99—Pinhead-Jojo complex, 0 to 12 percent slopes

Composition

Pinhead soil: 50 percent
Jojo soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Pinhead—level and concave benches; Jojo—convex benches and shoulders on ridgetops
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,200 to 6,400 feet
Native plants: Mountain hemlock, lodgepole pine, western white pine, subalpine fir, big huckleberry, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile of the Pinhead Soil

0 to 18 inches—dark brown very gravelly sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Properties and Qualities of the Pinhead Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 32 inches—reddish brown very gravelly and extremely gravelly sandy loam and loamy sand
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Piumpsha soils on concave benches
- Rock outcrop on shoulders

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Pinhead and Jojo—windthrow hazard and plant competition
- Jojo—equipment operability, seedling mortality, and fire damage

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Stones or boulders on the surface of the Jojo soil can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Cold winds and frost heaving may increase seedling mortality.
- The seedling mortality rate may be high in summer on the Jojo soil because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Jojo soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate or severe windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Jojo soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.

- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME/XETE, TSME-PICO/ARNE, TSME-PICO/VASC, and TSME-PICO-ALBA2

100—Pinhead-Jojo complex, 12 to 30 percent slopes

Composition

Pinhead soil: 60 percent
Jojo soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Pinhead—concave side slopes and foot slopes; Jojo—convex side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,200 to 6,400 feet
Native plants: Mountain hemlock, lodgepole pine, western white pine, subalpine fir, big huckleberry, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile of the Pinhead Soil

0 to 18 inches—dark brown very gravelly sandy loam
18 to 30 inches—dark yellowish brown extremely gravelly sandy loam
30 to 60 inches—dark yellowish brown extremely cobbly sandy loam

Properties and Qualities of the Pinhead Soil

Depth: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 3 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 32 inches—reddish brown very gravelly and extremely gravelly sandy loam and loamy sand
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Piumpsha soils on concave side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Pinhead and Jojo—equipment operability, soil displacement, seedling mortality, windthrow hazard, and plant competition
- Jojo—fire damage

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface of the Jojo soil can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Cold winds and frost heaving may increase seedling mortality.
- The seedling mortality rate on the Jojo soil may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Jojo soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate or severe windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.

- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Jojo soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME/XETE, TSME-PICO/ARNE, TSME-PICO/VASC, and TSME-PICO-ALBA2

101—Pipp very cobbly sandy loam, 12 to 30 percent slopes

Composition

Pipp soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,800 to 3,800 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—very dark brown very cobbly sandy loam
12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Simnasho soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, seedling mortality, and plant competition

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

• MIXED CONIFER/SYMPH and MIXED CONIFER/CEVE

102—Pipp very cobbly sandy loam, 30 to 65 percent slopes

Composition

Pipp soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: North-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,800 to 3,800 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
• Mean annual precipitation—30 to 40 inches
• Mean annual air temperature—41 to 43 degrees F
• Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—very dark brown very cobbly sandy loam
12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

• Simnasho soils on convex side slopes
• Rock outcrop on shoulders and upper side slopes

Major Uses

• Timber production and wildlife habitat

Major Management Limitations

Timber production
• Erosion hazard, equipment operability, soil displacement, seedling mortality, and plant competition

Use and Management

Timber production
• Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
• Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
• Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
• Using machinery only in areas covered with slash or brush reduces soil displacement.
• The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
• Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Wildlife habitat
• Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
• Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
• Dense stands of shrubs, saplings, and trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

• MIXED CONIFER/SYMPH and MIXED CONIFER/CEVE

103—Pipp very stony sandy loam, 12 to 30 percent slopes

Composition

Pipp soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains

Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,600 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—very dark brown very stony sandy loam
12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Simnasho soils on convex side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/SYMPH and MIXED CONIFER/CEVE

104—Pipp very stony sandy loam, 30 to 65 percent slopes

Composition

Pipp soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,600 to 5,000 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile

0 to 12 inches—very dark brown very stony sandy loam

12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Simnasho soils on convex side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Erosion hazard, equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Rock outcrop may cause breakage of timber and hinder yarding.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/SYMPH and MIXED CONIFER/CEVE

105—Pipp very stony sandy loam, low precipitation, 12 to 30 percent slopes

Composition

Pipp soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,200 to 3,600 feet
Native plants: Ponderosa pine, Douglas fir, antelope bitterbrush, snowbrush ceanothus, and Idaho fescue
Climatic factors:
- Mean annual precipitation—25 to 30 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—70 to 100 days

Typical Profile

0 to 12 inches—very dark brown very stony sandy loam
12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained

Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Simnasho soils on convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Livestock grazing
- None

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, and trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE

106—Pipp very stony sandy loam, low precipitation, 30 to 65 percent slopes

Composition

Pipp soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite and volcanic ash
Elevation: 2,200 to 3,600 feet
Native plants: Ponderosa pine, Douglas fir, antelope bitterbrush, snowbrush ceanothus, and Idaho fescue
Climatic factors:
- Mean annual precipitation—25 to 30 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—70 to 100 days

Typical Profile

0 to 12 inches—very dark brown very stony sandy loam
12 to 51 inches—dark yellowish brown extremely stony sandy loam
51 inches—fractured andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 4 to 7 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Simnasho soils on convex side slopes
- Rock outcrop on shoulders and upper side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Erosion hazard, equipment operability, soil displacement, seedling mortality, plant competition, and fire damage

Livestock grazing
- Rock outcrop and slope

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this soil may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.
- Stones or boulders on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- Rock outcrop may cause breakage of timber and hinder yarding.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Large amounts of rock fragments in the soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency are likely to result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes may adversely affect livestock distribution.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, and trees at least 2 to 5 acres in size and with at least 75 percent closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE

107—Piumpsha-Jojo complex, 2 to 30 percent slopes

Composition

Piumpsha soil: 60 percent
Jojo soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Piumpsha—benches and concave side slopes; Jojo—shoulders and convex side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite, pyroclastic ashflow, and volcanic ash
Elevation: 4,200 to 6,400 feet
Native plants: Mountain hemlock, lodgepole pine, western white pine, subalpine fir, big huckleberry, common beargrass, and grouse blueberry
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile of the Piumpsha Soil

0 to 8 inches—very dark brown gravelly sandy loam
8 to 27 inches—dark yellowish brown gravelly sandy loam
27 to 60 inches—dark brown gravelly clay loam

Properties and Qualities of the Piumpsha Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 4 to 8 inches

Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Jojo Soil

0 to 7 inches—dark brown very stony sandy loam
7 to 32 inches—reddish brown very gravelly sandy loam
32 inches—pyroclastic ashflow

Properties and Qualities of the Jojo Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Pinhead soils on concave side slopes and foot slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Piumpsha and Jojo—equipment operability, soil displacement, seedling mortality, and windthrow hazard
- Jojo—fire damage
- Piumpsha—soil compaction

Use and Management

Timber production
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- Stones or boulders on the surface of the Jojo soil can interfere with felling, yarding, and other operations involving the use of equipment.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer of the Piumpsha soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Cold winds and frost heaving may increase seedling mortality.
- The seedling mortality rate on the Jojo soil may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Jojo soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate or severe windthrow damage during periods of strong winds because of restricted rooting depth, high content of rock fragments, and exposed topography.
- If stands of timber are opened by shelterwood cuts, the risk of windthrow may increase.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Jojo soil.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- TSME-PICO-ABLA2 and TSME-PICO/ARNE

108—Prill gravelly silty clay loam, 30 to 55 percent slopes

Composition

Prill soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: North-facing side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from tuff
Elevation: 2,400 to 3,800 feet

Native plants: Antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, Oregon white oak, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 6 inches—black gravelly silty clay loam
6 to 28 inches—dark brown gravelly clay
28 to 35 inches—brown extremely cobbly silty clay
35 inches—tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kaskela soils on concave side slopes
- Rock outcrop on convex side slopes and shoulders

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Slope, Rock outcrop, and soil compaction

Use and Management

Livestock grazing
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Juniper-Oak Clayey

109—Prill-Kaskela complex, 2 to 30 percent slopes

Composition

Prill soil: 60 percent
Kaskela soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Prill—convex, north-facing side slopes; Kaskela—concave, north-facing side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from sedimentary rock and tuff
Elevation: 2,400 to 3,800 feet
Native plants: Antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, Oregon white oak, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Prill Soil

0 to 6 inches—black gravelly silty clay loam
6 to 28 inches—dark brown gravelly clay
28 to 35 inches—brown extremely cobbly silty clay
35 inches—tuff

Properties and Qualities of the Prill Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Kaskela Soil

0 to 4 inches—dark brown clay
4 to 31 inches—dark reddish brown clay
31 to 42 inches—reddish brown clay loam
42 inches—sedimentary rock

Properties and Qualities of the Kaskela Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Fawnspring soils on concave, forested side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Shrink-swell potential and soil compaction

Use and Management

Livestock grazing
- If this unit is seeded, use plants that tolerate the high shrink-swell potential.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Juniper-Oak Clayey

110—Prill-Kaskela-Rock outcrop complex, 2 to 30 percent slopes

Composition

Prill soil: 40 percent
Kaskela soil: 25 percent
Rock outcrop: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Prill—convex, south-facing side slopes; Kaskela—concave, south-facing side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from sedimentary rock and tuff
Elevation: 2,400 to 4,200 feet
Native plants: Antelope bitterbrush, bluebunch wheatgrass, Idaho fescue, western juniper, and ponderosa pine
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Prill Soil

0 to 6 inches—black gravelly silty clay loam
6 to 28 inches—dark brown gravelly clay
28 to 35 inches—brown extremely cobbly silty clay
35 inches—tuff

Properties and Qualities of the Prill Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Kaskela Soil

0 to 4 inches—dark brown clay
4 to 31 inches—dark reddish brown clay
31 to 42 inches—reddish brown clay loam
42 inches—sedimentary rock

Properties and Qualities of the Kaskela Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Kishwalk soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Shrink-swell potential, droughtiness, Rock outcrop, and soil compaction

Use and Management

Livestock grazing
- If this unit is seeded, use plants that tolerate the high shrink-swell potential.
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Seeding the more favorable areas of this unit may

be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Shrubby Mountain South 12-16 PZ (Shrubby South Exposure)

111—Prill-Rock outcrop complex, 30 to 55 percent slopes

Composition

Prill soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from tuff
Elevation: 2,400 to 4,200 feet
Native plants: Antelope bitterbrush, bluebunch wheatgrass, Idaho fescue, western juniper, and ponderosa pine
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Prill Soil

0 to 6 inches—black gravelly silty clay loam
6 to 28 inches—dark brown gravelly clay
28 to 35 inches—brown extremely cobbly silty clay
35 inches—tuff

Properties and Qualities of the Prill Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Kishwalk soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, slope, Rock outcrop, and soil compaction

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Shrubby Mountain South 12-16 PZ (Shrubby South Exposure)

112—Racing sandy loam, 0 to 3 percent slopes

Composition

Racing soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Drainageways
Landform: Mountain basins
Parent material: Mixed ash and alluvium derived from mixed sources
Elevation: 3,000 to 5,000 feet
Native plants: Engelmann spruce, lodgepole pine, sedges, and rushes
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Typical Profile

0 to 7 inches—dark brown sandy loam
7 to 11 inches—black muck
11 to 22 inches—dark gray silt loam
22 to 41 inches—light brownish gray very gravelly clay loam
41 to 51 inches—grayish brown extremely gravelly sand
51 to 60 inches—grayish brown very gravelly sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Poorly drained
Permeability: Very slow
Available water capacity: 6 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: 12 inches above the surface to 12 inches below the surface in April through June
Frequency of flooding: None

Contrasting Inclusions

- Mariel soils in nonforested areas

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, soil displacement, seedling mortality, windthrow hazard, and plant competition

Use and Management

Timber production
- The seasonal high water table restricts the use of equipment to midsummer when the soil is dry.
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- This soil is subject to a moderate soil compaction hazard because of the texture and the high water table.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- Use designated skid trails to minimize soil compaction.
- Cold winds and freezing of the surface layer increase seedling mortality.
- Trees are subject to severe windthrow damage during periods of strong winds because the rooting depth is restricted by the high water table.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 8 to 10 years after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- To reduce siltation and maintain temperatures of streams, areas of this soil adjacent to perennial streams and bogs need to be maintained as buffers.

Warm Springs Indian Reservation Plant Association

- PIEN-PICO/CAREX-JUNCU

113—Rockly extremely gravelly silt loam, 2 to 20 percent slopes

Composition

Rockly soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Scablands
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: *2,400* to 3,000 feet
Native plants: Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 3 inches—very dark grayish brown extremely gravelly silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Soil Properties and Qualities

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Bodell soils on side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock and droughtiness

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the limited soil depth.
- Shallow rooting depth limits the choice of species for range seeding to drought-tolerant varieties.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Very Shallow 14-18 PZ

114—Rockly-Watama complex, 0 to 8 percent slopes

Composition

Rockly soil: 60 percent
Watama soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Rockly—scablands of patterned ground; Watama—mounds of patterned ground (fig. 15)
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: 2,400 to 3,000 feet
Native plants: Rockly—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail; Watama—Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Rockly Soil

0 to 3 inches—very dark grayish brown very stony silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Properties and Qualities of the Rockly Soil

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Figure 15.—Typical area of Rockly-Watama complex, 0 to 8 percent slopes. This landscape is an example of patterned ground, locally referred to as "biscuit scabland."

Typical Profile of the Watama Soil

0 to 11 inches—very dark grayish brown silt loam
11 to 21 inches—dark brown silty clay loam
21 to 37 inches—dark brown silty clay loam
37 inches—basalt

Properties and Qualities of the Watama Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Wapinitia soils on large mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Rockly—depth to bedrock, droughtiness, and surface stones
- Rockly and Watama—soil compaction

Use and Management

Livestock grazing
- Pond development on the Rockly soil generally is impractical because of the limited soil depth.
- Shallow rooting depth of the Rockly soil limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the stones on the surface of the Rockly soil.
- Seeding the more favorable areas of this unit is difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Rockly—Very Shallow 14-18 PZ
- Watama—Loamy 12-16 PZ (Juniper Rolling Hills)

115—Rubble land-Rock outcrop complex, 30 to 80 percent slopes

Composition

Rubble land: 55 percent
Rock outcrop: 30 percent
Contrasting inclusions: 15

Setting

Landscape position: Side slopes
Landform: Canyons and mountains
Parent material: Basalt and andesite
Elevation: 1,400 to 5,000 feet
Native plants: Scattered conifers and hardwoods, shrubs, forbs, and grasses
Climatic factors:
- Mean annual precipitation—9 to 110 inches
- Mean annual air temperature—34 to 52 degrees F
- Frost-free period—10 to 160 days

Contrasting Inclusions

- Ruckles and Waterbury soils at the lower elevations
- Jojo and Piumpsha soils at the higher elevations

Major Uses

- Wildlife habitat, rock quarries, and recreational rock climbing

116—Ruckles-Rock outcrop complex, 55 to 80 percent slopes

Composition

Ruckles soil: 60 percent
Rock outcrop: 25 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt and tuff
Elevation: 1,200 to 2,800 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, Sandberg bluegrass, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very cobbly loam
4 to 8 inches—very dark brown extremely gravelly clay loam
8 to 18 inches—dark brown very gravelly clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow

Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Very rapid
Hazard of erosion: Very high

Rock Outcrop

Type of rock: Basalt

Contrasting Inclusions

- Ruclick soils on concave side slopes
- Day soils on foot slopes

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing
- Depth to bedrock, droughtiness, surface cobbles, slope, and aspect

Use and Management

Livestock grazing
- Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

- Droughty South 9-12 PZ (Droughty South Exposure)

117—Ruckles-Simas complex, 40 to 80 percent slopes

Composition

Ruckles soil: 40 percent
Simas soil: 35 percent
Contrasting inclusions: 25 percent

Setting

Landscape position: Ruckles—convex, north-facing side slopes; Simas—concave, north-facing side slopes
Landform: Canyons
Parent material: Ruckles—residuum and colluvium derived from basalt and tuff; Simas—residuum and colluvium derived from sedimentary rock with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Ruckles—bluebunch wheatgrass, Idaho fescue, big sagebrush, and western juniper; Simas—bluebunch wheatgrass, Idaho fescue, big sagebrush, and Sandberg bluegrass
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very cobbly silt loam
4 to 8 inches—very dark brown extremely gravelly clay loam
8 to 18 inches—dark brown very gravelly clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Simas Soil

0 to 9 inches—very dark brown cobbly silt loam
9 to 35 inches—dark brown clay
35 to 60 inches—yellowish brown gravelly clay loam

Properties and Qualities of the Simas Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Ruclick soils on concave side slopes
- Day soils on foot slopes
- Rock outcrop on upper, convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Ruckles and Simas—droughtiness and slope
- Ruckles—surface cobbles and depth to bedrock
- Simas—soil compaction

Use and Management

Livestock grazing
- Low annual precipitation and the shallow rooting depth of the Ruckles soil limit the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing on the Simas soil during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Ruckles—Shallow North 10-12 PZ
- Simas—Droughty North 10-12 PZ (Droughty North Exposure)

118—Ruckles-Simas-Rock outcrop complex, 40 to 80 percent slopes

Composition

Ruckles soil: 40 percent
Simas soil: 25 percent
Rock outcrop: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Ruckles—convex, south-facing side slopes; Simas—concave, south-facing side slopes
Landform: Canyons (fig. 16)
Parent material: Ruckles—residuum and colluvium derived from basalt and tuff; Simas—residuum and colluvium derived from sedimentary rock with an influence of loess
Elevation: 1,200 to 2,600 feet
Native plants: Ruckles—bluebunch wheatgrass, Sandberg bluegrass, Wyoming big sagebrush, antelope bitterbrush, and western juniper; Simas—bluebunch wheatgrass, big sagebrush, Idaho fescue, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very stony loam
4 to 18 inches—very dark brown very stony clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Simas Soil

0 to 9 inches—very dark brown very stony loam
9 to 35 inches—dark brown clay
35 to 60 inches—yellowish brown gravelly clay loam

Properties and Qualities of the Simas Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Basalt

Figure 16.—Area of Ruckles-Simas-Rock outcrop complex, 40 to 80 percent slopes, along the Deschutes River.

Contrasting Inclusions

- Ruclick soils on concave side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Ruckles and Simas—droughtiness, surface stones, Rock outcrop, slope, and aspect
- Ruckles—depth to bedrock

Use and Management

Livestock grazing
- Low annual precipitation and the shallow rooting depth of the Ruckles soil limit the choice of species for range seeding to drought-tolerant varieties.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep slopes and stones on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Ruckles—Droughty South 9-12 PZ (Droughty South Exposure)
- Simas—South 10-12 PZ (Juniper South Exposure)

119—Ruclick-Ruckles complex, 12 to 30 percent slopes

Composition

Ruclick soil: 50 percent
Ruckles soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Ruclick—concave, south-facing side slopes; Ruckles—convex, south-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt and tuff
Elevation: 1,200 to 2,800 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, and Sandberg bluegrass
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Ruclick Soil

0 to 4 inches—very dark brown very stony loam
4 to 14 inches—very dark grayish brown very cobbly silty clay loam
14 to 37 inches—dark brown very cobbly and extremely cobbly clay
37 inches—basalt

Properties and Qualities of the Ruclick Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very cobbly loam
4 to 8 inches—very dark brown extremely gravelly clay loam
8 to 18 inches—dark brown very gravelly clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Simas soils on foot slopes
- Rock outcrop on shoulders

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing
- Ruclick and Ruckles—droughtiness, surface stones and cobbles, and Rock outcrop
- Ruckles—depth to bedrock

Use and Management

Livestock grazing

- Low annual precipitation and the shallow rooting depth of the Ruckles soil limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the stones and cobbles on the surface.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.

Range Site

- Ruclick—South 10-12 PZ (Juniper South Exposure)
- Ruckles—Droughty South 9-12 PZ (Droughty South Exposure)

120—Ruclick-Ruckles complex, 30 to 55 percent slopes

Composition

Ruclick soil: 50 percent
Ruckles soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Ruclick—concave, south-facing side slopes; Ruckles—convex, south-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt and tuff
Elevation: 1,200 to 2,800 feet
Native plants: Wyoming big sagebrush, bluebunch wheatgrass, and Sandberg bluegrass
Climatic factors:

- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Ruclick Soil

0 to 4 inches—very dark brown very stony loam
4 to 14 inches—very dark grayish brown very cobbly silty clay loam
14 to 37 inches—dark brown very cobbly and extremely cobbly clay
37 inches—basalt

Properties and Qualities of the Ruclick Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very cobbly loam
4 to 8 inches—very dark brown extremely gravelly clay loam
8 to 18 inches—dark brown very gravelly clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Simas soils on foot slopes

Major Uses

- Livestock grazing

Major Management Limitations

Livestock grazing

- Ruclick and Ruckles—droughtiness, surface stones and cobbles, slope, and aspect
- Ruckles—depth to bedrock

Use and Management

Livestock grazing

- Low annual precipitation and the shallow rooting depth of the Ruckles soil limit the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and stones and cobbles on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Range Site

- Ruclick—South 10-12 PZ (Juniper South Exposure)
- Ruckles—Droughty South 9-12 PZ (Droughty South Exposure)

121—Sagley-Kishwalk complex, 12 to 30 percent slopes

Composition

Sagley soil: 50 percent
Kishwalk soil: 30 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Sagley—concave, north-facing side slopes; Kishwalk—convex, north-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from basalt with an influence of loess in the upper part
Elevation: 1,800 to 3,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Sagley Soil

0 to 18 inches—black silt loam
18 to 50 inches—very dark grayish brown very cobbly clay loam
50 inches—basalt

Properties and Qualities of the Sagley Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Kishwalk Soil

0 to 14 inches—very dark brown very cobbly silt loam
14 to 31 inches—very dark grayish brown very stony and extremely stony clay loam
31 to 38 inches—brown extremely stony clay
38 inches—basalt

Properties and Qualities of the Kishwalk Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Waterbury soils on shoulders and convex side slopes
- Loamy soils on concave foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Sagley and Kishwalk—soil compaction
- Kishwalk—surface cobbles

Use and Management

Livestock grazing
- Range seeding with ground equipment is impractical on the Kishwalk soil because of the cobbles on the surface.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD North 12-16 PZ (North Exposure)

122—Sagley-Kishwalk complex, 30 to 55 percent slopes

Composition

Sagley soil: 50 percent
Kishwalk soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Sagley—concave, north-facing side slopes; Kishwalk—convex, north-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived

dominantly from basalt with an influence of loess in the upper part
Elevation: 1,800 to 3,000 feet
Native plants: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, buckwheat, and milkvetch
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Sagley Soil

0 to 18 inches—black silt loam
18 to 50 inches—very dark grayish brown very cobbly clay loam
50 inches—basalt

Properties and Qualities of the Sagley Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 8 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Kishwalk Soil

0 to 14 inches—very dark brown very cobbly silt loam
14 to 31 inches—very dark grayish brown very stony and extremely stony clay loam
31 to 38 inches—brown extremely stony clay
38 inches—basalt

Properties and Qualities of the Kishwalk Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 4 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Kaskela soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Sagley and Kishwalk—slope and soil compaction (fig. 17)
- Kishwalk—surface cobbles

Figure 17.—Canyon along the Warm Springs River that is used for livestock grazing and wildlife habitat. Sagley-Kishwalk complex, 30 to 55 percent slopes, in foreground, and Waterbury-Rock outcrop complex, 55 to 80 percent slopes, on canyon walls in background.

Use and Management

Livestock grazing
- Steep slopes and cobbles on the surface of the Kishwalk soil may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Sagley—JD Clayey South 12-16 PZ
- Kishwalk—JD North 12-16 PZ (North Exposure)

123—Shiva fine sandy loam, 0 to 12 percent slopes

Composition

Shiva soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Slightly convex ridgetops
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice

Elevation: 2,200 to 2,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 4 inches—very dark brown fine sandy loam
4 to 18 inches—dark brown fine sandy loam
18 to 44 inches—dark brown gravelly fine sandy loam
44 to 60 inches—brown very gravelly fine sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Soils that are moderately deep to bedrock and are on convex shoulders

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Seepage

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Loamy 12-16 PZ (Juniper Rolling Hills)

124—Shiva fine sandy loam, 12 to 30 percent slopes

Composition

Shiva soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 2,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, big sagebrush, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 4 inches—very dark brown fine sandy loam
4 to 18 inches—dark brown fine sandy loam
18 to 44 inches—dark brown gravelly fine sandy loam
44 to 60 inches—brown very gravelly fine sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Moderately deep, ashy soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- None

Use and Management

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Sandy North 9-12 PZ (Sandy North Exposure)

125—Shiva fine sandy loam, 30 to 55 percent slopes

Composition

Shiva soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from volcanic ash and pumice
Elevation: 2,200 to 2,800 feet
Native plants: Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, big sagebrush, and western juniper
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 4 inches—very dark brown fine sandy loam
4 to 18 inches—dark brown fine sandy loam
18 to 44 inches—dark brown gravelly fine sandy loam
44 to 60 inches—brown very gravelly fine sandy loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Moderately deep, ashy soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Slope

Use and Management

Livestock grazing
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Sandy North 9-12 PZ (Sandy North Exposure)

126—Simas-Antoken complex, 2 to 30 percent slopes

Composition

Simas soil: 50 percent
Antoken soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: North-facing side slopes
Landform: Canyons and foothills
Parent material: Simas—residuum and colluvium derived from sedimentary rock with an influence of loess; Antoken—residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Simas Soil

0 to 9 inches—very dark brown cobbly silt loam
9 to 35 inches—dark brown clay
35 to 60 inches—yellowish brown gravelly clay loam

Properties and Qualities of the Simas Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow

Available water capacity: 6 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Antoken Soil

0 to 6 inches—very dark grayish brown extremely cobbly silt loam
6 to 10 inches—very dark grayish brown very cobbly silty clay loam
10 to 30 inches—dark brown very cobbly clay and silty clay
30 to 60 inches—light brown extremely cobbly loam and extremely stony sandy loam

Properties and Qualities of the Antoken Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Day soils on concave foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Simas and Antoken—droughtiness
- Simas—soil compaction
- Antoken—surface cobbles

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the cobbles on the surface of the Antoken soil.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing on the Simas soil during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty North 10-12 PZ (Droughty North Exposure)

127—Simas-Ruckles-Antoken complex, 2 to 40 percent slopes

Composition

Simas soil: 40 percent
Ruckles soil: 25 percent
Antoken soil: 25 percent
Contrasting inclusions: 10 percent

Figure 18.—Typical area of Simas-Ruckles-Antoken complex, 2 to 40 percent slopes, in foreground.

Setting

Landscape position: Side slopes
Landform: Canyons and foothills (fig. 18)
Parent material: Simas—residuum and colluvium derived from sedimentary rock with an influence of loess;
Ruckles—residuum and colluvium derived from basalt and tuff;
Antoken—residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Simas and Ruckles—bluebunch wheatgrass, Wyoming big sagebrush, Sandberg bluegrass, western juniper, and antelope bitterbrush; Antoken—bluebunch wheatgrass, Idaho fescue, big sagebrush, and Sandberg bluegrass

Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Simas Soil

0 to 9 inches—very dark brown cobbly silt loam
9 to 35 inches—dark brown clay
35 to 60 inches—yellowish brown gravelly clay loam

Properties and Qualities of the Simas Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Ruckles Soil

0 to 4 inches—very dark brown very cobbly silt loam
4 to 8 inches—very dark brown extremely gravelly clay loam
8 to 18 inches—dark brown very gravelly clay
18 inches—tuff

Properties and Qualities of the Ruckles Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Antoken Soil

0 to 6 inches—very dark grayish brown extremely cobbly silt loam
6 to 10 inches—very dark grayish brown very cobbly silty clay loam
10 to 30 inches—dark brown very cobbly clay and silty clay
30 to 60 inches—brown extremely cobbly loam and extremely cobbly loam

Properties and Qualities of the Antoken Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 6 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Day soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Simas, Antoken, and Ruckles—droughtiness
- Simas—soil compaction
- Antoken and Ruckles—surface cobbles
- Ruckles—depth to bedrock

Use and Management

Livestock grazing
- Pond development on the Ruckles soil generally is impractical because of the limited soil depth.
- Low annual precipitation and the shallow rooting depth of the Ruckles soil limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the cobbles on the surface of the Ruckles and Antoken soils.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing on the Simas soil during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Simas—South 10-12 PZ (Juniper South Exposure)
- Ruckles—Droughty South 9-12 PZ (Droughty South Exposure)
- Antoken—Droughty North 10-12 PZ (Droughty North Exposure)

128—Simnasho very cobbly sandy loam, 12 to 40 percent slopes

Composition

Simnasho soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Side slopes of drainageways
Landform: Mountains
Parent material: Residuum and colluvium derived

dominantly from andesite with a mantle of volcanic ash
Elevation: 2,600 to 3,600 feet
Native plants: Ponderosa pine, Douglas fir, antelope bitterbrush, snowbrush ceanothus, and Idaho fescue
Climatic factors:
- Mean annual precipitation—25 to 30 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—70 to 100 days

Typical Profile

0 to 16 inches—dark brown very cobbly sandy loam
16 to 24 inches—dark brown very cobbly sandy loam
24 to 33 inches—dark yellowish brown extremely cobbly loam
33 inches—weathered andesite

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Smiling soils on concave toe slopes
- Rock outcrop on shoulders

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil displacement, seedling mortality, windthrow hazard, and plant competition

Livestock grazing
- Rock outcrop

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in this soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Livestock grazing
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE

129—Skooker gravelly loam, 8 to 20 percent slopes

Composition

Skooker soil: 85 percent
Contrasting inclusions: 15 percent

Setting

L*andscape position:* Shoulders and side slopes of drainageways
Landform: Glacial outwash plains
Parent material: Glacial outwash with an influence of volcanic ash
Elevation: 2,600 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—16 to 20 inches

- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 16 inches—very dark brown gravelly loam
16 to 31 inches—dark brown gravelly silty clay loam
31 to 50 inches—dark brown extremely cobbly silty clay loam
50 inches—fractured sandstone

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 10 inches
Potential rooting depth: 40 to 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Tolius soils on concave side slopes
- Hehe soils on convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

130—Skooker-Tolius complex, 0 to 8 percent slopes

Composition

Skooker soil: 50 percent
Tolius soil: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Skooker—convex benches and drainageways; Tolius—level and concave benches
Landform: Glacial outwash plains
Parent material: Glacial outwash with an influence of volcanic ash
Elevation: 2,600 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Skooker Soil

0 to 16 inches—very dark brown gravelly loam
16 to 31 inches—dark brown gravelly silty clay loam

31 to 50 inches—dark brown extremely cobbly silty clay loam
50 inches—fractured sandstone

Properties and Qualities of the Skooker Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 4 to 10 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Tolius Soil

0 to 23 inches—very dark brown loam
23 to 49 inches—dark brown sandy clay loam and sandy loam
49 to 60 inches—brown loam

Properties and Qualities of the Tolius Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Milldam soils on nonforested benches
- Tenwalter soils on nonforested scablands

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Equipment operability, soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture and the low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

131—Skoven-Lavey complex, 2 to 15 percent slopes

Composition

Skoven soil: 60 percent
Lavey soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Skoven—scablands of patterned ground; Lavey—mounds of patterned ground
Landform: Low foothills
Parent material: Loess over colluvium derived from sedimentary rock and tuff
Elevation: 1,400 to 2,400 feet
Native plants: Skoven—Sandberg bluegrass, buckwheat, bluebunch wheatgrass, lomatium, and squirreltail; Lavey—bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, and western juniper
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Skoven Soil

0 to 3 inches—very dark grayish brown extremely gravelly silt loam
3 to 8 inches—dark brown very gravelly silty clay loam
8 to 11 inches—reddish brown extremely gravelly clay
11 to 21 inches—weathered tuff
21 inches—welded tuff

Properties and Qualities of the Skoven Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Lavey Soil

0 to 5 inches—dark brown gravelly silt loam
5 to 21 inches—dark grayish brown clay
21 to 25 inches—dark grayish brown silty clay loam
25 to 28 inches—weathered tuff
28 inches—welded tuff

Properties and Qualities of the Lavey Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Madras soils in level areas

Major Use

- Livestock grazing

Major Management Limitations

Livestock grazing
- Skoven and Lavey—droughtiness
- Skoven—depth to bedrock
- Lavey—soil compaction

Use and Management

Livestock grazing
- Pond development on the Skoven soil generally is impractical because of the limited soil depth.
- Low annual precipitation and the shallow rooting depth of the Skoven soil limit the choice of species for range seeding to drought-tolerant varieties.
- Grazing on the Lavey soil during wet periods can cause soil compaction and damage plants.

Range Site

- Skoven—Buckwheat Scabland 9-12 PZ
- Lavey—Droughty Loam 8-10 PZ (Arid Rolling Hills)

132—Smiling-Simnasho complex, 0 to 12 percent slopes

Composition

Smiling soil: 50 percent
Simnasho soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Smiling—level and concave benches; Simnasho—convex benches and side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 2,600 to 3,600 feet
Native plants: Ponderosa pine, Douglas fir, antelope bitterbrush, snowbrush ceanothus, and Idaho fescue
Climatic factors:
- Mean annual precipitation—25 to 30 inches
- Mean annual air temperature—42 to 44 degrees F
- Frost-free period—70 to 100 days

Typical Profile of the Smiling Soil

0 to 9 inches—dark brown sandy loam
9 to 33 inches—dark brown sandy loam
33 to 56 inches—brown gravelly loam
56 inches—weathered andesite

Properties and Qualities of the Smiling Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 8 to 12 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Simnasho Soil

0 to 16 inches—dark brown very stony sandy loam
16 to 24 inches—dark brown very cobbly sandy loam
24 to 33 inches—dark yellowish brown extremely cobbly loam
33 inches—weathered andesite

Properties and Qualities of the Simnasho Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Pipp soils on convex benches and side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Smiling and Simnasho—plant competition
- Smiling—soil compaction and soil displacement
- Simnasho—equipment operability, seedling mortality, and windthrow hazard

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer of the Smiling soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate on the Simnasho soil may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Simnasho soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Simnasho soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.

Livestock grazing
- Grazing on the Smiling soil during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR-CEVE

133—Smiling-Simnasho complex, high precipitation, 0 to 12 percent slopes

Composition

Smiling soil: 50 percent
Simnasho soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Smiling—level and concave benches; Simnasho—convex benches and side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash
Elevation: 2,600 to 4,000 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, snowbrush ceanothus, common snowberry, golden chinkapin, and starflower
Climatic factors:
- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Typical Profile of the Smiling Soil

0 to 9 inches—dark brown sandy loam
9 to 33 inches—dark brown sandy loam
33 to 56 inches—brown gravelly loam
56 inches—weathered andesite

Properties and Qualities of the Smiling Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 8 to 12 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Simnasho Soil

0 to 16 inches—dark brown very stony sandy loam
16 to 24 inches—dark brown very cobbly sandy loam
24 to 33 inches—dark yellowish brown extremely cobbly loam
33 inches—weathered andesite

Properties and Qualities of the Simnasho Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Pipp soils on convex benches and side slopes

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Smiling and Simnasho—plant competition
- Smiling—soil compaction and soil displacement
- Simnasho—windthrow hazard and equipment operability

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Stones on the surface can interfere with felling, yarding, and other operations involving the use of equipment.
- The surface layer of the Smiling soil is subject to a moderate soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate on the Simnasho soil may be high in summer because of inadequate moisture in the soil.
- Large amounts of rock fragments in the Simnasho soil make planting of bare-root tree seedlings difficult and reduce seedling survival.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth and high content of rock fragments in the Simnasho soil.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial establishment of trees.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/SYMPH and MIXED CONIFER/CEVE

134—Sorf very gravelly loam, 30 to 55 percent slopes

Composition

Sorf soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Foothills

Parent material: Residuum and colluvium derived from sedimentary rock with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Bluebunch wheatgrass, Wyoming big sagebrush, Thurber needlegrass, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 6 inches—very dark grayish brown very gravelly loam
6 to 23 inches—dark brown clay
23 to 26 inches—dark yellowish brown clay loam
26 inches—calcareous tuff

Soil Properties and Qualities

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Simas soils on concave side slopes
- Ruckles soils on convex side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness, slope, and aspect

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- South 10-12 PZ (Juniper South Exposure)

135—Sorf-Simas complex, 2 to 30 percent slopes

Composition

Sorf soil: 50 percent
Simas soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Sorf—convex, south-facing side slopes; Simas—concave, south-facing side slopes
Landform: Foothills
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of loess
Elevation: 1,400 to 2,400 feet
Native plants: Wyoming big sagebrush, Thurber needlegrass, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Sorf Soil

0 to 6 inches—very dark grayish brown very gravelly loam
6 to 23 inches—dark brown clay
23 to 26 inches—dark yellowish brown clay loam
26 inches—calcareous tuff

Properties and Qualities of the Sorf Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Simas Soil

0 to 9 inches—very dark brown silt loam
9 to 35 inches—dark brown clay
35 to 60 inches—yellowish brown gravelly clay loam

Properties and Qualities of the Simas Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 6 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Day soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Droughtiness and soil compaction

Use and Management

Livestock grazing
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- South 10-12 PZ (Juniper South Exposure)

136—Spilyay-Bodell complex, 2 to 30 percent slopes

Composition

Spilyay soil: 50 percent
Bodell soil: 40 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Spilyay—concave benches and side slopes; Bodell—scablands
Landform: Canyons
Parent material: Residuum and colluvium derived dominantly from semiconsolidated conglomerate, tuff, and basalt with an influence of volcanic ash in the upper part
Elevation: 2,200 to 3,400 feet
Native plants: Spilyay—ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass; Bodell—Sandberg bluegrass, onespike oatgrass, bluebunch wheatgrass, and Idaho fescue
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Spilyay Soil

0 to 8 inches—very dark grayish brown very cobbly loam
8 to 15 inches—dark brown clay loam
15 to 41 inches—dark yellowish brown clay
41 to 60 inches—dark brown silt loam

Properties and Qualities of the Spilyay Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 8 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Bodell Soil

0 to 4 inches—dark brown very stony loam
4 to 14 inches—dark brown extremely cobbly clay loam
14 inches—basalt

Properties and Qualities of the Bodell Soil

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Happus soils on concave side slopes

Major Uses

- Spilyay—timber production and wildlife habitat
- Bodell—livestock grazing and wildlife habitat

Major Management Limitations

Timber production
- Spilyay—equipment operability, soil compaction, seedling mortality, windthrow hazard, plant competition, and fire damage

Livestock grazing
- Bodell—depth to bedrock and soil compaction

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.

- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- The Spilyay soil is subject to a severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth in this soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing
- Pond development on the Bodell soil generally is impractical because of the limited soil depth.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

Range Site

- Moist Scabland 14-18 PZ

137—Suppah very gravelly sandy loam, 12 to 30 percent slopes

Composition

Suppah soil: 90 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from volcanic ash and pumice
Elevation: 1,600 to 2,800 feet
Native plants: Big sagebrush, needleandthread, antelope bitterbrush, western juniper, and Sandberg bluegrass
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 10 inches—very dark brown very gravelly sandy loam
10 to 26 inches—dark grayish brown very gravelly and extremely gravelly sandy loam
26 to 60 inches—light gray pumice

Soil Properties and Qualities

Depth: Moderately deep to pumice (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 1 to 2 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Ruclick soils on concave side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Seepage and droughtiness

Use and Management

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Pumice Hills 8-10 PZ (Sand Hills)

138—Suppah-Ruclick complex, 12 to 30 percent slopes

Composition

Suppah soil: 55 percent
Ruclick soil: 35 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Suppah—convex, south-facing side slopes; Ruclick—concave, south-facing side slopes
Landform: Canyons
Parent material: Suppah—residuum and colluvium derived from volcanic ash and pumice; Ruclick—residuum and colluvium derived from basalt and tuff
Elevation: 1,600 to 2,800 feet
Native plants: Suppah—big sagebrush, needleandthread, antelope bitterbrush, western juniper, and Sandberg bluegrass; Ruclick—bluebunch wheatgrass, Wyoming big sagebrush, Thurber needlegrass, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Suppah Soil

0 to 10 inches—very dark brown very gravelly sandy loam
10 to 26 inches—dark grayish brown very gravelly and extremely gravelly sandy loam
26 to 60 inches—light gray pumice

Properties and Qualities of the Suppah Soil

Depth: Moderately deep to pumice (20 to 40 inches)
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid
Available water capacity: 1 to 2 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Ruclick Soil

0 to 4 inches—very dark brown very stony loam
4 to 14 inches—very dark grayish brown very cobbly silty clay loam
14 to 37 inches—dark brown very cobbly and extremely cobbly clay
37 inches—basalt

Properties and Qualities of the Ruclick Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Contrasting Inclusions

- Bakeoven soils on scablands

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Suppah and Ruclick—droughtiness
- Suppah—seepage
- Ruclick—surface stones

Use and Management

Livestock grazing
- Pond development on the Suppah soil generally is impractical because of the risk of seepage.
- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical on the Ruclick soil because of the stones on the surface.
- Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.

Wildlife habitat
- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Suppah—Pumice Hills 8-10 PZ (Sand Hills)
- Ruclick—South 10-12 PZ (Juniper South Exposure)

139—Teewee loam, 0 to 3 percent slopes

Composition

Teewee soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Level and concave benches
Landform: Mountains
Parent material: Residuum and colluvium derived from andesite or basalt with an influence of volcanic ash
Elevation: 2,600 to 3,300 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—14 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 11 inches—dark brown loam
11 to 18 inches—dark brown loam
18 to 43 inches—dark brown clay loam
43 to 53 inches—dark brown very stony clay loam
53 inches—weathered andesite

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Hehe soils on convex benches and side slopes
- Bodell soils on scablands

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- The surface layer is subject to a severe soil compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

140—Teewee-Bodell-Logsprings complex, 0 to 8 percent slopes

Composition

Teewee soil: 40 percent
Bodell soil: 30 percent
Logsprings soil: 25 percent
Contrasting inclusions: 5 percent

Setting

Landscape position: Teewee—convex benches; Bodell—convex scablands; Logsprings—concave benches
Landform: Mountains and foothills
Parent Material: Residuum and colluvium derived dominantly from sedimentary rock, basalt, and andesite with an influence of volcanic ash in the upper part
Elevation: 2,600 to 2,800 feet
Native plants: Teewee—ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass; Bodell—onespike oatgrass, Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue; Logsprings—ponderosa pine,

antelope bitterbrush, mule's-ear, and prairie smoke

Climatic factors:

- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Teewee Soil

0 to 11 inches—dark brown loam
11 to 18 inches—dark brown loam
18 to 43 inches—dark brown clay loam
43 to 53 inches—dark brown very stony clay loam
53 inches—weathered andesite

Properties and Qualities of the Teewee Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Bodell Soil

0 to 4 inches—dark brown very cobbly loam
4 to 14 inches—dark brown extremely gravelly clay loam
14 inches—basalt

Properties and Qualities of the Bodell Soil

Depth: Shallow (12 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 12 to 20 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Logsprings Soil

0 to 10 inches—dark grayish brown loam
10 to 21 inches—brown loam
21 to 30 inches—dark brown clay
30 to 36 inches—dark brown extremely gravelly sandy clay loam
36 to 64 inches—dark brown loam

Properties and Qualities of the Logsprings Soil

Depth: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Permeability: Slow
Available water capacity: 8 to 13 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Fawnspring soils in drainageways

Major Uses

- Teewee, Bodell, and Logsprings—livestock grazing and wildlife habitat
- Teewee and Logsprings—timber production

Major Management Limitations

Timber production

- Teewee and Logsprings—soil compaction, seedling mortality, and plant competition

Livestock grazing

- Bodell—depth to bedrock
- Teewee, Bodell, and Logsprings—soil compaction

Use and Management

Timber production

- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- This unit is subject to a severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees on the Teewee soil.

Livestock grazing

- Pond development on the Bodell soil generally is impractical because of the limited soil depth.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- Teewee—PIPO/PUTR
- Logsprings—PIPO/GETR-WYAM (Mutton)

Range Site

- Bodell—Moist Scabland 14-18 PZ

141—Tenwalter-Kahneeta complex, 0 to 3 percent slopes

Composition

Tenwalter soil: 55 percent
Kahneeta soil: 35 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Tenwalter—scablands; Kahneeta—drainageways
Landform: Outwash plains
Parent material: Residuum derived from glacial outwash with an influence of loess in the upper part
Elevation: 2,800 to 3,000 feet
Native plants: Tenwalter—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail; Kahneeta—tufted hairgrass, rushes, sedges, and bluegrass
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Tenwalter Soil

0 to 11 inches—very dark grayish brown very cobbly silt loam
11 to 15 inches—dark brown extremely cobbly clay
15 to 27 inches—duripan
27 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Tenwalter Soil

Depth: Shallow to a duripan (10 to 20 inches); very deep to bedrock (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 3 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow
Hazard of erosion: Slight

Typical Profile of the Kahneeta Soil

0 to 4 inches—black very cobbly silt loam
4 to 16 inches—dark brown very cobbly silty clay loam
16 to 25 inches—brown extremely cobbly clay
25 to 38 inches—duripan
38 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Kahneeta Soil

Depth: Moderately deep (20 to 30 inches) to a duripan; very deep to bedrock (more than 60 inches)
Drainage class: Somewhat poorly drained
Permeability: Slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 30 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: 6 to 18 inches below the surface in March through June

Contrasting Inclusions

- Millcreek soils on mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Tenwalter and Kahneeta—surface cobbles and soil compaction
- Tenwalter—depth to duripan
- Kahneeta—high water table

Use and Management

Livestock grazing
- If seeding is needed on the Kahneeta soil, select plants that tolerate seasonal wetness
- Pond development on the Tenwalter soil generally is impractical because of the limited soil depth.
- Range seeding with ground equipment is impractical because of cobbles on the surface.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Tenwalter—Very Shallow 14-18 PZ
- Kahneeta—Mountain Meadow

142—Tenwalter-Milldam complex, 0 to 3 percent slopes

Composition

Tenwalter soil: 60 percent
Millcreek soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Tenwalter—scablands of patterned ground; Milldam—mounds of patterned ground
Landform: Outwash plains
Parent material: Residuum derived from glacial outwash with an influence of loess in the upper part
Elevation: 2,600 to 3,000 feet
Native plants: Tenwalter—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail; Milldam—Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, Sandberg bluegrass, and buckwheat
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Tenwalter Soil

0 to 11 inches—very dark grayish brown very cobbly silt loam
11 to 15 inches—dark brown extremely cobbly clay
15 to 27 inches—duripan
27 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Tenwalter Soil

Depth: Shallow to a duripan (10 to 20 inches); very deep to bedrock (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 3 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow
Hazard of erosion: Slight

Typical Profile of the Milldam Soil

0 to 10 inches—very dark brown silt loam
10 to 34 inches—dark brown silty clay loam
34 to 37 inches—brown cobbly clay
37 to 51 inches—duripan
51 to 60 inches—brown extremely cobbly clay

Properties and Qualities of the Milldam Soil

Depth: Moderately deep to a duripan (30 to 40 inches); very deep to bedrock (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 30 to 40 inches
Runoff: Slow
Hazard of erosion: Slight

Contrasting Inclusions

- Kahneeta soils in concave drainageways

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Tenwalter and Milldam—soil compaction
- Tenwalter—depth to duripan and surface cobbles

Use and Management

Livestock grazing
- Pond development on the Tenwalter soil generally is impractical because of the limited soil depth.
- Range seeding with ground equipment is impractical because of the cobbles on the surface of the Tenwalter soil.
- Seeding the more favorable areas of this unit is difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Some areas of this unit provide critical winter range for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Tenwalter—Very Shallow 14-18 PZ
- Milldam—Shrubby Loam 12-16 PZ (Shrubby Rolling Hills)

143—Tolius loam, 0 to 8 percent slopes

Composition

Tolius soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Nearly level benches
Landform: Glacial outwash plains
Parent material: Glacial outwash with an influence of volcanic ash

Elevation: 2,600 to 3,000 feet
Native plants: Ponderosa pine, antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, and prairie junegrass
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—47 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile

0 to 23 inches—very dark brown loam
23 to 49 inches—dark brown sandy clay loam and sandy loam
49 to 60 inches—brown loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 11 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Skooker soils on shoulders and side slopes of drainageways
- Milldam soils in nonforested areas

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil compaction, seedling mortality, and plant competition

Livestock grazing
- Soil compaction

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- The surface layer has a severe compaction hazard because of the texture.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO/PUTR

144—Typic Vitricryands, 2 to 70 percent slopes

Composition

Typic Vitricryands: 75 percent
Contrasting inclusions: 25 percent

Setting

Landscape position: Side slopes
Landform: Mt. Jefferson and Olallie Butte
Parent material: Residuum and colluvium derived dominantly from rhyolite, andesite, pyroclastic ashflow, and volcanic ash
Elevation: 5,000 to 7,000 feet
Native plants: Scattered, stunted conifers and shrubs, forbs, and grasses
Climatic factors:
- Mean annual precipitation—80 to 110 inches
- Mean annual air temperature—34 to 36 degrees F
- Frost-free period—10 to 30 days

Reference Profile

0 to 8 inches—dark brown extremely stony sandyloam
8 to 18 inches—very dark gray extremely cobbly loamy sand
18 to 29 inches—very dark grayish brown extremely cobbly sand
29 to 60 inches—very dark brown pyroclastic ashflow

Soil Properties and Qualities

Depth: Moderately deep to very deep (20 to 60 inches or more)
Drainage class: Excessively drained
Permeability: Moderately rapid
Available water capacity: 2 to 7 inches
Potential rooting depth: 20 to 60 inches
Runoff: Slow to very rapid
Hazard of erosion: Slight to very high

Contrasting Inclusions

- Jojo and Piumpsha soils on lower, concave side slopes and in concave pockets
- Rubble land on convex side slopes

Major Use

- Wildlife habitat

145—Venator-Rock outcrop complex, 2 to 30 percent slopes

Composition

Venator soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Mountains
Parent material: Colluvium and residuum derived from sedimentary rock
Elevation: 1,600 to 4,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Venator Soil

0 to 4 inches—very dark grayish brown extremely channery loam
4 to 18 inches—dark brown very channery and extremely channery loam
18 inches—fractured sedimentary rock

Properties and Qualities of the Venator Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Oldsferry soils on concave side slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Depth to bedrock, Rock outcrop, and droughtiness

Use and Management

Livestock grazing
- Pond development on this unit generally is impractical because of the limited soil depth.
- Low annual precipitation and the shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Clayey South 12-16 PZ (South Exposure)

146—Vitrandic Haploxerolls, 0 to 8 percent slopes

Composition

Vitrandic Haploxerolls: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Drainageways
Landform: Mountains
Parent material: Alluvium derived from mixed sources with an influence of volcanic ash
Elevation: 2,600 to 3,800 feet
Native plants: Ponderosa pine, Douglas fir, grand fir, common snowberry, golden chinkapin, and starflower
Climatic factors:

- Mean annual precipitation—30 to 40 inches
- Mean annual air temperature—41 to 43 degrees F
- Frost-free period—60 to 90 days

Reference Profile

0 to 5 inches—very dark grayish brown gravelly loam
5 to 35 inches—dark brown very gravelly sandy loam
35 to 60 inches—dark yellowish brown very gravelly sandy clay loam

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained to somewhat excessively drained
Permeability: Moderate
Available water capacity: 6 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Millerflat soil on stream terraces
- Simnasho soils on side slopes of drainageways

Major Uses

- Timber production and wildlife habitat

Major Management Limitations

Timber production
- Equipment limitations, soil compaction, seedling mortality, and plant competition

Use and Management

Timber production
- Conventional methods of harvesting timber generally are suitable, but using low-pressure ground equipment and designated skid trails damages the soil less and helps to maintain productivity.
- Logging roads for year-round use require heavy base rock.
- Logging may be restricted during November through April because of soil wetness.
- The surface layer is subject to a severe soil compaction hazard because of the texture and the low content of rock fragments.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Skid trails and landings that are not intended for permanent use should be ripped when the soil is dry.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- To compensate for the expected high mortality rate, plant larger seedlings or a higher number of seedlings.
- Unless site preparation is adequate, competition from undesirable plants can prevent natural or artificial reestablishment of trees.
- Competing vegetation can be reduced by mechanical or chemical treatment.

Wildlife habitat
- Forage for big game animals can be produced for 10 years or more after the canopy is opened by logging, fire, or other disturbance.
- Dense, multistory stands of timber at least 30 acres in size and with at least 70 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for elk.
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this soil to provide escape and thermal cover for deer.
- To reduce siltation and maintain temperatures of streams, areas of this soil adjacent to perennial streams may need to be maintained as buffers.

Warm Springs Indian Reservation Plant Association

- MIXED CONIFER/SYMPH

147—Wakamo-Rock outcrop complex, 2 to 30 percent slopes

Composition

Wakamo soil: 50 percent
Rock outcrop: 35 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Wakamo—ridgetops and convex side slopes; Rock outcrop—shoulders and upper side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash
Elevation: 2,600 to 4,000 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, common snowberry, and heartleaf arnica
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Wakamo Soil

0 to 11 inches—very dark grayish brown very gravelly loam
11 to 15 inches—dark brown extremely gravelly clay loam
15 to 18 inches—dark brown extremely gravelly clay
18 inches—fractured sedimentary rock

Properties and Qualities of the Wakamo Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Mowako soils on concave side slopes
- Venator soils on nonforested, convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, seedling mortality, windthrow hazard, and plant competition

Livestock grazing
- Depth to bedrock and Rock outcrop

Use and Management

Timber production
- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- Rock outcrop may cause breakage of timber and hinder yarding.
- This unit is subject to a severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to severe windthrow damage during periods of strong winds because of the restricted rooting depth, high content of rock fragments, and exposed topography.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.

Livestock grazing
- Pond development on this unit generally is impractical because of the limited soil depth.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/SYMPH (Mutton)

148—Walsey-Axford complex, 30 to 55 percent slopes

Composition

Walsey soil: 60 percent
Axford soil: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Walsey—convex, north-facing side slopes; Axford—concave, north-facing side slopes
Landform: Canyons
Parent material: Residuum and colluvium derived from basalt with an influence of loess
Elevation: 1,200 to 2,800 feet
Native plants: Bluebunch wheatgrass, Sandberg bluegrass, Idaho fescue, big sagebrush, and milkvetch
Climatic factors:
- Mean annual precipitation—9 to 12 inches

- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile of the Walsey Soil

0 to 11 inches—very dark brown extremely cobbly silt loam
11 to 19 inches—dark brown very cobbly silty clay loam
19 to 39 inches—brown very gravelly loam and extremely gravelly silt loam
39 inches—weathered basalt

Properties and Qualities of the Walsey Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 2 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Typical Profile of the Axford Soil

0 to 11 inches—very dark brown silt loam
11 to 24 inches—dark brown clay loam
24 to 46 inches—yellowish brown silt loam and gravelly silt loam
46 inches—weathered basalt

Properties and Qualities of the Axford Soil

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 6 to 9 inches
Potential rooting depth: 40 to 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Contrasting Inclusions

- Antoken soils on foot slopes

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

- Walsey and Axford—droughtiness, slope, and soil compaction
- Walsey—surface cobbles

Use and Management

Livestock grazing

- Low annual precipitation limits the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and cobbles on the surface of the Walsey soil may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

- On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Droughty North 10-12 PZ (Droughty North Exposure)

149—Wapinitia silt loam, 0 to 8 percent slopes

Composition

Wapinitia soil: 85 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Nearly level benches
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: 2,400 to 3,000 feet
Native plants: Antelope bitterbrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and buckwheat
Climatic factors:

- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile

0 to 14 inches—black silt loam
14 to 22 inches—dark brown silt loam
22 to 44 inches—dark brown clay loam
44 to 58 inches—dark yellowish brown loam
58 inches—basalt

Soil Properties and Qualities

Depth: Deep (40 to 60 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 7 to 12 inches
Potential rooting depth: 40 to 60 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Watama soils on moderately deep mounds
- Rockly soils on scablands

Major Uses

- Cropland and livestock grazing

Major Management Limitations

Cropland
- Permeability, soil compaction, and slope

Livestock grazing
- Soil compaction

Use and Management

Cropland
- In summer, irrigation is needed for maximum production of most crops.
- Because of the moderately slow permeability of the subsoil, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.
- The silt loam surface layer in this soil is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.
- Care should be taken when using surface irrigation on slopes of more than 3 percent.

Livestock grazing
- Grazing during wet periods can cause soil compaction and displacement and damage plants.

Range Site

- Shrubby Loam 12-16 PZ (Shrubby Rolling Hills)

150—Watama-Rockly complex, 0 to 8 percent slopes

Composition

Watama soil: 65 percent
Rockly soil: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Watama—mounds of patterned ground; Rockly—scablands of patterned ground
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: 2,400 to 3,000 feet
Native plants: Watama—Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper; Rockly—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Watama Soil

0 to 11 inches—very dark grayish brown silt loam
11 to 21 inches—dark brown silty clay loam
21 to 37 inches—dark brown silty clay loam
37 inches—basalt

Properties and Qualities of the Watama Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Rockly Soil

0 to 3 inches—very dark grayish brown very stony silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Properties and Qualities of the Rockly Soil

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Wapinitia soils on large mounds

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Watama and Rockly—soil compaction

• Rockly—depth to bedrock, droughtiness, and surface stones

Use and Management

Livestock grazing

• Pond development on the Rockly soil generally is impractical because of the limited soil depth.
• Shallow rooting depth of the Rockly soil limits the choice of species for range seeding to drought-tolerant varieties.
• Range seeding with ground equipment is impractical because of the stones on the surface of the Rockly soil.
• Seeding the more favorable areas of this unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
• Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat

• On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• Watama—Loamy 12-16 PZ (Juniper Rolling Hills)
• Rockly—Very Shallow 14-18 PZ

151—Watama-Rockly complex, leveled, 0 to 3 percent slopes

Composition

• Variable because of land leveling

Setting

Landscape position: Leveled patterned ground
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: 2,400 to 3,000 feet
Native plants: Watama—Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper; Rockly—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail
Climatic factors:
• Mean annual precipitation—12 to 16 inches
• Mean annual air temperature—48 to 50 degrees F
• Frost-free period—100 to 140 days

Typical Profile of the Watama Soil

0 to 11 inches—very dark grayish brown silt loam
11 to 21 inches—dark brown silty clay loam
21 to 37 inches—dark yellowish brown silty clay loam
37 inches—basalt

Properties and Qualities of the Watama Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow
Hazard of erosion: Slight

Typical Profile of the Rockly Soil

0 to 3 inches—very dark grayish brown very stony silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Properties and Qualities of the Rockly Soil

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow
Hazard of erosion: Slight

Figure 19.—Established stand of intermediate wheatgrass in an area of Watama-Rockly complex, leveled, 0 to 3 percent slopes. Mutton Mountains in background.

Major Uses

• Cropland and livestock grazing (fig. 19)

Major Management Limitations

Cropland
- Watama and Rockly—permeability and soil compaction
- Rockly—depth to bedrock

Livestock grazing
- Soil compaction

Use and Management

Cropland
- In summer, irrigation is needed for maximum production of most crops.
- Because of the moderately slow permeability of the subsoil, care should be taken to prevent excessive irrigation rates that may lead to overland flow.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.
- The silt loam surface layer in this soil is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Watama—Loamy 12-16 PZ (Juniper Rolling Hills)
- Rockly—Very Shallow 14-18 PZ

152—Watama-Rockly complex, gravelly, 0 to 8 percent slopes

Composition

Watama soil: 70 percent
Rockly soil: 25 percent
Contrasting inclusions: 5 percent

Setting

Landscape position: Watama—mounds of patterned ground; Rockly—scablands of patterned ground
Landform: Mesas
Parent material: Colluvium derived from basalt with an influence of loess in the upper part
Elevation: 2,400 to 3,000 feet
Native plants: Watama—Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper; Rockly—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail
Climatic factors:
- Mean annual precipitation—12 to 16 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Watama Soil

0 to 11 inches—very dark grayish brown gravelly silt loam
11 to 21 inches—dark brown silty clay loam
21 to 37 inches—dark brown silty clay loam
37 inches—basalt

Properties and Qualities of the Watama Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Typical Profile of the Rockly Soil

0 to 3 inches—very dark grayish brown extremely gravelly silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Properties and Qualities of the Rockly Soil

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow or medium
Hazard of erosion: Slight or moderate

Contrasting Inclusions

- Tenwalter soils on glacial outwash plains

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Watama—soil compaction
- Rockly—depth to bedrock and droughtiness

Use and Management

Livestock grazing
- Pond development on the Rockly soil generally is impractical because of the limited soil depth.
- Shallow rooting depth of the Rockly soil limits the choice of species for range seeding to drought-tolerant varieties.

• Grazing on the Watama soil during wet periods can cause soil compaction and damage plants.

Wildlife habitat

• On noncritical winter and summer range, 20 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

• Watama—Loamy 12-16 PZ (Juniper Rolling Hills)
• Rockly—Very Shallow 14-18 PZ

153—Watama-Rockly-Prill complex, 2 to 30 percent slopes

Composition

Watama soil: 40 percent
Rockly soil: 25 percent
Prill soil: 25 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: Watama—mounds of patterned ground; Rockly—scablands of patterned ground; Prill—convex side slopes
Landform: Mesas and foothills
Parent material: Residuum and colluvium derived from basalt and tuff with an influence of loess in the upper part
Elevation: 2,400 to 3,400 feet
Native plants: Watama—Idaho fescue, bluebunch wheatgrass, buckwheat, big sagebrush, antelope bitterbrush, and western juniper; Rockly—Sandberg bluegrass, buckwheat, onespike oatgrass, lomatium, and squirreltail; Prill—Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, Oregon white oak, western juniper, and buckwheat
Climatic factors:
• Mean annual precipitation—12 to 16 inches
• Mean annual air temperature—48 to 50 degrees F
• Frost-free period—100 to 140 days

Typical Profile of the Watama Soil

0 to 11 inches—very dark grayish brown silt loam
11 to 21 inches—dark brown silty clay loam
21 to 37 inches—dark brown silty clay loam
37 inches—basalt

Properties and Qualities of the Watama Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 3 to 8 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Rockly Soil

0 to 3 inches—very dark grayish brown very stony silt loam
3 to 9 inches—dark brown very cobbly silt loam and extremely cobbly silty clay loam
9 inches—basalt

Properties and Qualities of the Rockly Soil

Depth: Very shallow (4 to 10 inches)
Drainage class: Well drained
Permeability: Moderately slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 4 to 10 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Prill Soil

0 to 6 inches—black gravelly silty clay loam
6 to 28 inches—dark brown gravelly clay
28 to 35 inches—brown extremely cobbly silty clay
35 inches—tuff

Properties and Qualities of the Prill Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

• Wapinitia soils on mounds
• Kaskela soils on concave side slopes

Major Uses

• Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing

• Watama, Rockly, and Prill—soil compaction
• Rockly—depth to bedrock and surface stones

Use and Management

Livestock grazing

• Pond development on the Rockly soil generally is impractical because of the limited soil depth.
• Range seeding with ground equipment is impractical on the Rockly soil because of the stones on the surface.
• Seeding the more favorable areas of this

unit may be difficult or impractical because of the pattern in which they occur with the less favorable areas.
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- Watama—Loamy 12-16 PZ (Juniper Rolling Hills)
- Rockly—Very Shallow 14-18 PZ
- Prill—Juniper-Oak Clayey

154—Waterbury-Kishwalk complex, 2 to 30 percent slopes

Composition

Waterbury soil: 45 percent
Kishwalk soil: 35 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Waterbury—convex, south-facing side slopes; Kishwalk—concave, south-facing side slopes
Landform: Canyons
Parent material: Colluvium derived from basalt and rhyolite
Elevation: 1,800 to 3,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Waterbury Soil

0 to 3 inches—very dark brown extremely stony loam
3 to 8 inches—very dark brown very stony clay loam
8 to 16 inches—dark brown extremely stony clay
16 inches—basalt

Properties and Qualities of the Waterbury Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Typical Profile of the Kishwalk Soil

0 to 14 inches—very dark brown very stony loam
14 to 31 inches—very dark grayish brown very stony and extremely stony clay loam
31 to 38 inches—brown extremely stony clay
38 inches—basalt

Properties and Qualities of the Kishwalk Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 7 inches
Potential rooting depth: 20 to 40 inches
Runoff: Slow to rapid
Hazard of erosion: Slight to high

Contrasting Inclusions

- Kaskela soils on foot slopes
- Prill soils on foot slopes
- Rock outcrop on shoulders

Major Uses

- Livestock grazing and wildlife habitat

Major Management Limitations

Livestock grazing
- Waterbury—depth to bedrock
- Waterbury and Kishwalk—droughtiness and surface stones

Use and Management

Livestock grazing
- Pond development on the Waterbury soil generally is impractical because of the limited soil depth.
- Low annual precipitation and the shallow rooting depth of the Waterbury soil limit the choice of species for range seeding to drought-tolerant varieties.
- Range seeding with ground equipment is impractical because of the stones on the surface.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Clayey South 12-16 PZ (South Exposure)

155—Waterbury-Rock outcrop complex, 55 to 80 percent slopes

Composition

Waterbury soil: 60 percent
Rock outcrop: 30 percent
Contrasting inclusions: 10 percent

Setting

Landscape position: South-facing side slopes
Landform: Canyons
Parent material: Colluvium derived from basalt and rhyolite
Elevation: 1,800 to 3,000 feet
Native plants: Bluebunch wheatgrass, Idaho fescue, buckwheat, western juniper, and antelope bitterbrush
Climatic factors:
- Mean annual precipitation—12 to 14 inches
- Mean annual air temperature—48 to 50 degrees F
- Frost-free period—100 to 140 days

Typical Profile of the Waterbury Soil

0 to 3 inches—very dark brown extremely stony loam
3 to 8 inches—very dark brown very stony clay loam
8 to 16 inches—dark brown extremely stony clay
16 inches—basalt

Properties and Qualities of the Waterbury Soil

Depth: Shallow (10 to 20 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 1 to 2 inches
Potential rooting depth: 10 to 20
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Basalt

Contrasting Inclusions

- Kishwalk soils on concave side slopes and foot slopes

Major Uses

- Livestock grazing and wildlife habitat (see fig. 17, page 142)

Major Management Limitations

Livestock grazing
- Droughtiness, surface stones, slope, Rock outcrop, and aspect

Use and Management

Livestock grazing
- Low annual precipitation and shallow rooting depth limit the choice of species for range seeding to drought-tolerant varieties.
- Steep slopes and stones on the surface may adversely affect livestock distribution and make range seeding with ground equipment impractical.
- The Rock outcrop in this unit reduces the areas suitable for grazing and may restrict accessibility by livestock.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Range Site

- JD Clayey South 12-16 PZ (South Exposure)

156—Willowdale loam, 0 to 3 percent slopes

Composition

Willowdale soil: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Bars and channels
Landform: Flood plains
Parent material: Alluvium derived from mixed sources
Elevation: 1,100 to 1,600 feet
Native plants: Basin wildrye, bluegrass, slender wheatgrass, and basin big sagebrush
Climatic factors:
- Mean annual precipitation—9 to 12 inches
- Mean annual air temperature—50 to 52 degrees F
- Frost-free period—110 to 160 days

Typical Profile

0 to 24 inches—very dark grayish brown loam
24 to 48 inches—very dark brown loam
48 to 60 inches—variegated sand and gravel

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Moderate
Available water capacity: 7 to 10 inches
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: More than 6 feet
Frequency of flooding: Rare

Contrasting Inclusions

- Pelton soils on back swamps
- Riverwash adjacent to channels

Major Uses

- Cropland and livestock grazing

Major Management Limitations

Cropland
- Leaching, groundwater contamination, and soil compaction

Livestock grazing
- Seepage and soil compaction

Use and Management

Cropland
- Low annual precipitation restricts annual cropping unless supplemental irrigation is used.
- To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the soil moisture content, the water intake rate, and the needs of the crop grown.
- Leaching of applied fertilizers and chemicals and groundwater contamination may occur on this soil because of the rapid permeability of the substratum.
- The loam surface layer in this soil is subject to compaction from excessive tillage.
- Reduce soil compaction by returning crop residue to the soil and keeping tillage at a minimum.

Livestock grazing
- Pond development on this soil generally is impractical because of the risk of seepage.
- Grazing during wet periods can cause soil compaction and damage plants.

Range Site

- Loamy Bottom (Moist Bottom)

157—Xerofluvents, 0 to 3 percent slopes

Composition

Xerofluvents: 80 percent
Contrasting inclusions: 20 percent

Setting

Landscape position: Small, irregular areas along major streams that include low flood plains, islands, bars, overflow channels, and oxbows
Landform: Stream terraces
Parent material: Mixed alluvium
Elevation: 1,400 to 2,600 feet
Native plants: Grasses, sedges, shrubs, hardwoods, and conifers
Climatic factors:
- Mean annual precipitation—9 to 16 inches
- Mean annual air temperature—48 to 52 degrees F
- Frost-free period—100 to 160 days

Reference Profile

0 to 6 inches—very dark grayish brown gravelly silt loam
6 to 15 inches—brown very gravelly loam
15 to 31 inches—dark brown extremely cobbly sandy clay loam
31 to 43 inches—dark brown extremely cobbly sandy loam
43 to 60 inches—dark brown extremely cobbly loamy sand

Soil Properties and Qualities

Depth: Very deep (more than 60 inches)
Drainage class: Variable
Permeability: Moderately slow to very rapid
Available water capacity: Variable
Potential rooting depth: More than 60 inches
Runoff: Slow
Hazard of erosion: Slight
Depth to water table: 12 to 36 inches below the surface in December through May
Frequency of flooding: Occasional

Contrasting Inclusions

- Pelton soils on flood plains
- Riverwash adjacent to channels

Major Uses

- Wildlife habitat

Major Management Limitations

- Streamside degradation

Use and Management

Wildlife habitat

- Because most areas of these soils are adjacent to the Warm Springs River, above the fish hatchery, areas adjacent to perennial streams may need to be maintained as buffers to reduce siltation and maintain temperatures of streams.

158—Yawkola-Jorn-Rock outcrop complex, 2 to 30 percent slopes

Composition

Yawkola soil: 35 percent
Jorn soil: 30 percent
Rock outcrop: 30 percent
Contrasting inclusions: 5 percent

Setting

Landscape position: Yawkola—concave, south-facing side slopes; Jorn—convex, south-facing side slopes; Rock outcrop—shoulders and convex, south-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of volcanic ash in the upper part
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, antelope bitterbrush, and Idaho fescue
Climatic factors:

- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Yawkola Soil

0 to 11 inches—very dark grayish brown very gravelly silt loam
11 to 40 inches—dark brown very gravelly silty clay
40 to 60 inches—dark yellowish brown gravelly silt loam

Properties and Qualities of the Yawkola Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Typical Profile of the Jorn Soil

0 to 5 inches—very dark brown cobbly silt loam
5 to 12 inches—very dark grayish brown gravelly silty clay loam
12 to 21 inches—dark brown gravelly silty clay
21 to 24 inches—dark brown gravelly silty clay
24 inches—sedimentary rock

Properties and Qualities of the Jorn Soil

Depth: Moderately deep (20 to 40 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 3 to 5 inches
Potential rooting depth: 20 to 40 inches
Runoff: Medium or rapid
Hazard of erosion: Moderate or high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Bodell soils on shoulders and convex side slopes

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production

- Yawkola and Jorn—soil erosion, equipment operability, soil compaction, seedling mortality, and plant competition
- Yawkola—fire damage
- Jorn—windthrow hazard

Livestock grazing

- Soil compaction

Use and Management

Timber production

- Reduce the risk of erosion on skid trails and temporary roads by seeding, installing water bars, or accumulating slash on the surface.
- Wheeled and tracked equipment can be used in the more gently sloping areas, but cable yarding generally is safer and disturbs the soil less.
- Logging roads for year-round use require heavy base rock.
- Rock outcrop may cause breakage of timber and hinder yarding.
- This unit has a moderate or severe soil compaction hazard because of the texture of the surface layer and the clayey subsoil.
- Restrict the use of equipment to periods when the

soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Trees are subject to moderate windthrow damage during periods of strong winds because of the restricted rooting depth of the Jorn soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the Yawkola soil.

Livestock grazing
- Grazing during wet periods can cause soil compaction and damage plants.

Wildlife habitat
- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR (Mutton)

159—Yawkola-Rock outcrop complex, 30 to 55 percent slopes

Composition

Yawkola soil: 55 percent
Rock outcrop: 30 percent
Contrasting inclusions: 15 percent

Setting

Landscape position: Yawkola—concave, south-facing side slopes; Rock outcrop—convex, south-facing side slopes
Landform: Mountains
Parent material: Residuum and colluvium derived from sedimentary rock with an influence of volcanic ash in the upper part
Elevation: 2,600 to 3,500 feet
Native plants: Ponderosa pine, Douglas fir, Oregon white oak, antelope bitterbrush, and Idaho fescue
Climatic factors:
- Mean annual precipitation—16 to 20 inches
- Mean annual air temperature—45 to 49 degrees F
- Frost-free period—90 to 120 days

Typical Profile of the Yawkola Soil

0 to 11 inches—very dark grayish brown very gravelly loam
11 to 40 inches—dark brown very gravelly silty clay
40 to 60 inches—dark yellowish brown gravelly silt loam

Properties and Qualities of the Yawkola Soil

Depth: Very deep (more than 60 inches)
Drainage class: Well drained
Permeability: Slow
Available water capacity: 5 to 9 inches
Potential rooting depth: More than 60 inches
Runoff: Rapid or very rapid
Hazard of erosion: High or very high

Rock Outcrop

Type of rock: Sedimentary

Contrasting Inclusions

- Jorn soils on convex side slopes
- Logsprings soils on nearly level benches

Major Uses

- Timber production, livestock grazing, and wildlife habitat

Major Management Limitations

Timber production
- Soil erosion, equipment operability, soil compaction, soil displacement, seedling mortality, plant competition, and fire damage

Livestock grazing
- Slope and aspect

Use and Management

Timber production
- Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless plant cover or adequate water bars, or both, are provided.
- Disturbance of this unit may result in instability of the slope. The factors that affect the stability of the slope should be evaluated before the soil is disturbed.
- Because of the steepness of slope, logging systems that fully or partially suspend logs are best suited.

- Logging roads for year-round use require heavy base rock.
- Rock outcrop may cause breakage of timber and hinder yarding.
- This unit is subject to a moderate soil compaction hazard because of the texture of the surface layer.
- Restrict the use of equipment to periods when the soil is dry or frozen to reduce compaction.
- Use designated skid trails to minimize soil compaction.
- Using machinery only in areas covered with slash or brush reduces soil displacement.
- The seedling mortality rate may be high in summer because of inadequate moisture in the soil.
- Unless site preparation is adequate, competition from undesirable plants can prolong natural or artificial reestablishment of trees.
- Increased erosion, loss of nutrients, and water repellency may result from fires that have moderate fireline intensity. Prescribed burning should be designed carefully to minimize detrimental impacts to the soil.

Livestock grazing

- Steep slopes may adversely affect livestock distribution.
- Steep, south-facing slopes are less suited to grazing in hot periods during the grazing season.

Wildlife habitat

- Dense stands of shrubs, saplings, or trees at least 2 to 5 acres in size and with at least 75 percent crown closure should be left in some areas of this unit to provide escape and thermal cover for deer.
- On critical winter range, 50 percent of the available animal-unit-months should be allocated to wildlife.

Warm Springs Indian Reservation Plant Association

- PIPO-PSME/PUTR (Mutton)

Prime Farmland

In this section, prime farmland is defined and discussed and the prime farmland soils in this survey area are listed.

Prime farmland is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, seed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. Adequate moisture and a sufficiently long growing season are required. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food and fiber or are available for these uses. Urban or built-up land, public land, and water areas cannot be considered prime farmland. Urban or built-up land is any contiguous unit of land 10 acres or more in size that is used for such purposes as housing, industrial, and commercial sites and as sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water control structures. Public land is land not available for farming in national forests, national parks, military reservations, and state parks.

Prime farmland soils commonly get an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and length of growing season are favorable, and level of acidity or alkalinity is acceptable. The soils have few, if any, rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Natural Resources Conservation Service.

A recent trend in land use has been the conversion of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on lands that are less productive than prime farmland.

About 18,238 acres, or approximately 3 percent of the survey area, would meet the requirements for prime farmland if an adequate and dependable supply of irrigation water were available.

The following map units meet the soil requirements for prime farmland when irrigated. On some soils included in the list, measures should be used to overcome a hazard or limitation, such as flooding, wetness, or droughtiness. The location of each map unit is shown on the detailed soil maps at the back of this publication. Soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

Map Symbol	Soil Name
25	Drybed silt loam, 0 to 8 percent slopes
77	Madras loam, 0 to 8 percent slopes
80	Maupin silt loam, 0 to 8 percent slopes
89	Olallie clay loam, 0 to 3 percent slopes (where drained)
94	Pelton-Willowdale complex, 0 to 3 percent slopes
149	Wapinitia silt loam, 0 to 8 percent slopes
156	Willowdale loam, 0 to 3 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and for hay and pasture is suggested in this section. The system of land capability classification used by the Natural Resources Conservation Service is explained, and the estimated yields of the main crops and hay and pasture plants commonly grown are listed for each soil. Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading “Detailed Soil Map Units.” Specific information can be obtained from the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

Approximately 26,000 acres of the survey area has favorable soil characteristics and climatic conditions for crop production. Currently, about 600 acres is used for crops. Of this, about 240 acres is irrigated. The majority of this cropland is adjacent to Tenino Creek and the Warm Springs River. Potential cropland is scattered throughout the eastern half of the survey area, but the majority of it is on Mill Creek Flat, Schoolie Flat, and Webster Flat and adjacent to Tenino and Dry Creeks.

Soils have properties that affect their response to use and management. Susceptibility to erosion by water, leaching and groundwater contamination, and soil compaction are important considerations in the management of areas used for crops and pasture. Proper irrigation water management also is important.

Erosion results in the loss of organic matter, breakdown of soil structure, and change in soil texture through the loss of silt and clay, all of which degrade soil tilth and productivity. The replacement of soil lost through erosion takes many years. Many structural, management, and vegetative practices are used to reduce or control water erosion. Use of cover crops or crop residue reduces the impact of raindrops and decreases the erosive energy of water. Plant cover also allows water to infiltrate the soil profile instead of running off the surface and causing accelerated erosion. Slope is an important factor in determining the hazard of water erosion. Soils that have slopes of more than 3 percent are more susceptible to erosion, and thus more protection is needed.

In summer, irrigation is needed for maximum production of most crops. Various crops require differing amounts of water for full production. Adequate water is needed during critical growth stages to maintain high production or desirable crop

quality. Among the soil characteristics that affect the choice of irrigation systems are the available water capacity and the water intake rate. Available water capacity is the amount of water a soil can store for crop growth. Available water capacity is dependent upon soil texture, depth to bedrock, total rock fragment content, and organic matter content. The water intake rate is determined by the soil texture, soil structure, and organic matter content. Sandy soils have a high water intake rate and a low available water capacity, but clayey soils absorb water slowly and have a relatively high available water capacity.

Sprinkler irrigation is a suitable method of applying water. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. To avoid overirrigating and leaching of plant nutrients and chemicals, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the needs of the crop grown.

Returning crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures helps to maintain organic matter content and soil tilth and reduces the risk of compaction.

The survey area has a wide range of soils and climatic conditions that influence the management of areas used for crops and pasture.

The Drybed, Madras (see fig. 14, page 102), Pelton, and Willowdale soils have the most favorable characteristics and climatic conditions for irrigated crop production. These soils are on flood plains and terraces adjacent to Dry and Tenino Creeks and the Warm Springs and Deschutes Rivers. Elevation is 1,100 to 2,400 feet. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees F, and the frost-free period is 110 to 160 days. Potential crops that can be grown under irrigation include winter wheat, barley, alfalfa hay, and pasture.

The Drybed soils are moderately fine textured and are very deep to bedrock, the Madras soils are moderately fine textured and are moderately deep to bedrock, the Pelton soils are moderately coarse textured and are very deep to mixed alluvium, and the Willowdale soils are medium textured and are deep to variegated sand and gravel. The Drybed, Madras, and Pelton soils are limited by the slow permeability of the subsoil, which contributes to overland flow if the irrigation rate exceeds the permeability rate.

Soil material transported by water carries associated nutrients and chemicals into waterways and reservoirs and reduces water quality. As a result of the texture of the surface layer, the Drybed, Madras, and Willowdale soils are subject to compaction from excessive tillage and from grazing when the soils are wet. The Drybed and Madras soils are susceptible to water erosion if surface irrigation is used in areas that have slopes of more than 3 percent. The Willowdale soils are limited by moderate permeability, which may result in leaching and subsequent groundwater contamination from plant nutrients and chemicals.

The Maupin, Olallie, Wapinitia, and Watama soils also have favorable characteristics and climatic conditions for crop production. These soils are on nearly level to gently sloping mesas.

The Maupin soils are dominantly northeast and south of Warm Springs, adjacent to the Deschutes River. Elevation is 2,000 to 2,400 feet. The mean annual precipitation is 9 to 12 inches, the mean annual air temperature is 50 to 52 degrees, and the frost-free period is 110 to 160 days. Potential crops that can be grown on the Maupin soils include winter wheat, barley, alfalfa hay, and pasture.

The Olallie, Wapinitia, and Watama soils are dominantly on Mill Creek Flat and Schoolie Flat. Most areas of the Olallie soils are adjacent to Sidwalter Buttes. Elevation is 2,400 to 3,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 48 to 50 degrees, and the frost-free period is 100 to 140 days. Potential crops that can be grown on the Wapinitia and Watama soils include winter wheat, barley, alfalfa hay, and pasture. Potential crops that can be grown on the Olallie soils if artificial drainage is provided are alfalfa hay and pasture.

The Maupin soils are medium textured and are moderately deep to a duripan; the Olallie soils are moderately fine textured, very deep to mixed alluvium, and poorly drained; the Wapinitia soils are moderately fine textured and are deep to bedrock; and the Watama soils are moderately fine textured and are moderately deep to bedrock. The Maupin soils are limited by moderate permeability and depth to a duripan, which may result in leaching and subsequent groundwater contamination from plant nutrients and chemicals. The Olallie soils are limited by a high water table, which can affect the season of use unless artificial drainage is provided. The Wapinitia and Watama soils are limited by slow permeability in the subsoil, which contributes to overland flow if the irrigation rate exceeds the permeability rate. Because of the texture of the surface layer, the Maupin, Olallie, Wapinitia, and Watama soils are subject to compaction from excessive tillage and from grazing when the soils are wet. The Maupin, Wapinitia, and Watama soils are susceptible to water erosion if surface irrigation is used in areas that have slopes of more than 3 percent.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop grown. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting methods that ensure the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils generally are grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification for each soil is given in table 5.

Rangeland and Grazeable Forest Land

By David Smith, range conservationist, Bureau of Indian Affairs.

Rangeland and grazeable forest land comprise approximately 450,000 acres, or about 69 percent of the survey area. Grazing by domestic livestock historically has been significant in the development of the land and the lifestyles of the Warm Springs Tribes. Although the number of livestock has declined in recent years, grazing by cattle and horses still is vital to the local economy and to the individual ranchers in the area.

Historically, livestock grazing in the survey area began in 1860 when settlers and traders introduced horses, sheep, and cattle into central Oregon. Tribal members primarily used horses as a means of transportation and cattle as a supplemental food source.

In the early 1900's, large bands of sheep owned by tribal members and non-Indians were introduced into the area. The sheep extensively grazed the forested areas and river canyons. By 1926, several bands totaling 6,600 head had been driven from railheads in Portland, Oregon. These bands grazed in the high mountainous areas between Mt. Hood and Mt. Jefferson and in the Mutton Mountains and the Deschutes River Basin. In 1931, the Tribal Council of the Warm Springs Tribes decided to reserve their grazing lands exclusively for livestock owned by tribal members. Leases held by non-Indian sheep and cattle producers were terminated, and they have not been renewed.

The number of tribal members involved in livestock and agricultural production grew steadily between 1900 and 1984. Entire families were involved in the care, maintenance, and movement of livestock herds and in farming. Livestock were grazed in the lower, nonforested areas in winter and spring, and they were slowly and systematically moved onto the higher grazeable forest land in summer and fall. Families moved their living facilities, called "summer camps," as the herds were moved. Livestock grazing in the forested areas of the survey area was reduced significantly in the early 1960's with the construction of the "APW" fence. Grazing since has been limited primarily to areas at the lower elevations.

The number of cattle and horses grazing on tribal land and individually owned Indian land has varied significantly over the past decade. The number of livestock climbed to a high of 2,500 cattle and 1,700 horses between 1900 and 1961, but the number was reduced significantly by severe winters or by wholesale liquidation of stock by individual owners.

In 1984 a significant reduction in the number of horses resulted from a program initiated by the Confederated Tribes of the Warm Springs Reservation and the Bureau of Indian Affairs. This program, known as the Equine Infectious Anemia (EIA) Program, was conducted between 1980 and 1983 to curb this infectious disease in horses. The program effectively reduced the horse population by 50 percent.

An increase in herd management by individual livestock owners and by grazing districts has led to further reductions in uncontrolled livestock populations. Overall, livestock populations have rebounded since 1984 because most of the ranches in the area are traditional cow-calf and mare-colt operations.

Grazing Allotments

The rangeland and grazeable forest land in the survey area are subdivided into eight distinct grazing units. These units are defined by natural topographic boundaries and fencelines. Most of the grazing units are subdivided into two or more pastures by interior fences. Grazing systems that regularly rotate livestock and incorporate "traditional use areas" are used on these pastures by tribal livestock owners. A few small, isolated, individually owned allotments do not have fenced subdivisions. These allotments are used primarily by the landowners during a specific season.

Many upland areas in the grazing units have plant communities that receive little, if any, use because of a lack of water or a low level of management. Annual grazing plans and ongoing range development programs are being used to effectively manage this upland forage through herding, fencing, water developments, and livestock management practices.

Primary goals of the tribes include proper use of the forage in the survey area and reduction of use in areas where livestock have concentrated in the past, such as riparian areas. More intensive management and resource education programs are being used to help control use of the riparian areas. Any long-term changes in the number of livestock or season of use are subject to the specifications of updated grazing plans approved by the Tribal Council.

Grazing Districts

The survey area is divided into eight grazing districts. Boundaries were set by Tribal Council Resolution for the Sidwalter, Boulder/Miller Flat/Dry Creek/Webster, Metolius, and 4-H Grazing Districts. Since the development of the Range and Agriculture Plan in 1984, the boundaries of the Simnasho/Log Springs, Mutton Mountain, and Tenino Grazing

Districts officially have been defined. The McQuinn Act set the boundaries of the Wapinitia Grazing District.

Grazing districts were established by Tribal Council Resolution to govern and regulate grazing in the survey area. Through the adoption of Ordinance 66, the Tribal Council established a method whereby grazing districts would manage the grazing land under the Tribal Comprehensive Plan and Ordinances to protect the grazing resources.

Ordinance 66 provided the following:

1. Tribal livestock owners in each grazing area would present, in writing for approval by the Tribal Council, a document stating their organization and operating procedures.
2. After approval of the organization and operating procedures, grazing districts and the Tribal/Bureau of Indian Affairs (BIA) Range and Agriculture Department would develop 5-year goals and an initial annual grazing plan for approval by the Tribal Natural Resources Director, the Tribal Council, and the Tribal Superintendent. Subsequent annual plans would be approved by the Natural Resources Director.
3. After approval of the grazing plan, a grazing authorization would be issued by the Tribal Council and Superintendent to the grazing district with the specific conditions of the 5-year plan.
4. The Tribal/BIA Range and Agriculture Department would be responsible for assisting grazing districts with development and implementation of the plan and for monitoring the operations to ensure the accomplishment of the grazing plan.

Grazing Management

As described in the preceding paragraphs, each grazing district meets with the Tribal/BIA Range and Agriculture Department to discuss and prepare an annual grazing plan. Annual grazing plans are guides for stock rotations within the pastures that meet the biological needs of the forage species; meet the developmental needs, such as water developments, fencing, and enforcement problems; establish work priorities; and schedule grazing rotations that eliminate resource use conflicts among grazing stock and wildlife, cultural food plants, fisheries, and riparian areas.

The Tribal/BIA Range and Agriculture Department annually assists in monitoring the condition of the forage, the patterns of use, and the sale and movement of livestock within the districts.

Management Concerns

This section provides information about concerns and limitations that are important to the management of livestock grazing in the survey area. More information is given in the section “Detailed Soil Map Units.”

Aspect is the direction in which a slope faces. North-facing slopes are cooler, more productive, and slower in development of new growth than other slopes. During hot periods in summer, north-facing slopes are preferred by livestock because they are cooler and the forage stays green until later in summer.

South-facing slopes generally have the opposite characteristics of north-facing slopes. South-facing slopes are poorly suited to livestock grazing during hot periods in summer, and they produce less forage for grazing. Most east- and west-facing slopes have soil and site characteristics similar to those of south-facing slopes.

Slope affects livestock use and the feasibility of range improvement. Steep slopes are less preferred for grazing than gentle slopes. Slopes of more than 50 percent, such as those on canyonsides, generally are used very little even if the forage is abundant, because livestock prefer the gentler slopes. Light use of the steep slopes generally is anticipated, however, and proper stocking rates should be determined accordingly.

Rock outcrop normally supports very little vegetation. In areas that have a significant amount of Rock outcrop, the capacity of the land for grazing is reduced proportionately. Livestock access also may be restricted in these areas, further reducing the available forage, unless access trails are developed.

Droughtiness reduces forage production and limits the choice of plants for seeding to drought-tolerant species. Droughtiness is a result of low annual precipitation or of soil characteristics such as coarse texture, shallow depth, or a high content of gravel or stones, all of which restrict available water capacity.

Some *soil characteristics* affect the use and management of rangeland. Soil texture affects water infiltration rates and the susceptibility of the soil to damage from mechanical operations. Soil temperature affects the rate of plant growth and maturation. Heavy-textured soils have a slow infiltration rate, have a higher rate of runoff, and may be damaged easily by grazing during wet periods. Coarse-textured soils are susceptible to wind erosion

if left bare. Soil characteristics should be considered in range management activities such as the timing, duration, and intensity of grazing to ensure the protection of plant and soil resources.

Water is the primary limiting factor in the development and improvement of grazing land in the survey area. Although abundant water is available in perennial streams and natural springs, development of these sources has been limited over the years. Water is a key element in the proper management of grazing sites and in the protection and enhancement of the plant communities.

Conflicts of land use among grazing areas, anadromous fish spawning areas, riparian areas, and cultural plant-gathering sites increase when there is a shortage of water during periods of continuous drought. An aggressive resource enhancement program has been undertaken by the Warm Springs Tribes to reduce these conflicts and to improve water conditions on grazing land. Using modern technology, the tribes have improved water conditions and reduced the conflicts in the use of the land resources by developing water sources for livestock and wildlife. These developments include construction of deep wells and pipelines and troughs, use of an aggressive spring development program in areas of rangeland, use of solar-powered pumping systems, use of big game guzzlers to capture precipitation and channel it to watering troughs, use of hydro-ram pumping systems to divert water away from sensitive riparian areas and stream channels for use by livestock, and construction of stock dams to capture overland flow.

Fencing is another key element in an effective grazing management program. It is used to properly distribute livestock across a grazing area and to properly time the use of forage. Many methods of fencing can be used, including subdividing large grazeable areas into smaller units.

The tribes have been constructing fences to divide each of the large grazing districts into more manageable units. Approximately 30 miles of fence were built annually between 1984 and 1991. Dividing the land into small units by using fences and natural boundaries helps to improve grazing management. There are still some large areas of more than 45,000 acres in the survey area, and additional fencing is needed to improve the movement of herds and the use of forage in these areas.

Forage Resources

The survey area is unique in its diversity and complexity of plant community types and forage species, which is illustrated by the general vegetation map included at the back of this publication. In addition to the historic and economic importance of rangeland for livestock grazing, it is also important for soil protection, flood control, water production, wildlife habitat, fishery habitat, and recreational opportunities and as a source of firewood and juniper boughs.

Rangeland and grazeable forest land produce edible native plants that are essential to the diet and culture of the Warm Springs Tribes. Plants gathered for food and medicine include roots, berries, moss, herbs, and bulbs.

The lower elevation rangeland consists of general soil map units 1, 2, 3, and 4. The plant communities range from high condition communities that support Sandberg bluegrass, bluebunch wheatgrass, and Idaho fescue to low condition communities that support dominantly medusahead and cheatgrass. The plant communities that are in poor condition and are dominantly annual grasses are a direct result of prolonged, heavy grazing from the 1880's to the 1930's and from farming activities that were abandoned in the early 1960's.

The middle elevation grazeable forest land consists of general soil map units 5, 6, 7, 8, 9, 10, and 11. It includes forest land in the pine and pine/Douglas fir zones. The plant communities within these zones range from bunchgrass/bitterbrush communities to pine/bitterbrush and pine/Douglas fir/elk sedge communities. Primary forage species include Sandberg bluegrass, bluebunch wheatgrass, Idaho fescue, bitterbrush, and elk sedge. Lower condition communities generally are dominated by squirreltail, cheatgrass, and some medusahead. Within the timbered areas, snowbrush ceanothus and greenleaf manzanita are shrub species that flourish following disturbances such as logging and fire. Some moist meadows that yield large quantities of grasses and forbs are in these areas.

High elevation grazeable forest land consists of general soil map unit 12. It includes forest land ranging from the Douglas fir/sedge zone to the true fir zone. Although grazing is limited in these areas, the forage is important to wildlife. The primary forage species are sedges, snowbrush ceanothus, greenleaf manzanita, golden chinkapin, big huckleberry, and common snowberry. Moist or wet meadows are common, and they produce large quantities of camas, sedges, rushes, and grasses.

Forage Production

Forage production varies from site to site. Characteristics such as precipitation, soil types, plant community ecological conditions, soil surface

conditions, and overstory canopy closures contribute directly to the production of forage.

Approximately 60 percent of the rangeland in the survey area is producing less than half of its natural potential. Past grazing and farming activities, catastrophic fires, and drought have significantly altered the structure and production of the plant communities.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on range sites are closely related to soil types. Effective management is based on the relationship between the soils and the vegetation and availability of water.

Range site management requires a knowledge of soil characteristics and the associated potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential native plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not infer value of the present plant community for a given use.

Table 6 shows, for each soil that is used as rangeland or grazeable forest land or is suitable for these uses, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruit of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation, the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil, is listed by common name. Under *composition,* the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

An objective in range site management is to manage grazing so that the plants growing on a site are similar in kind and amount to the potential natural plant community for that site, while improving the overall ecological condition of the plant community. Management that improves range condition generally results in the optimal production of vegetation, a reduction in undesirable brush species, conservation of water, and reduced erosion. Sometimes, however, based upon the needs of the tribes and the objectives for the land in a given area, range conditions below the ecological potential meet grazing needs, provide for wildlife habitat, and adequately protect soil and water resources.

Special Provisions for Listing Range Sites

In 1983 a survey was conducted on the Warm Springs Indian Reservation of all low-elevation rangeland and some middle-elevation grazeable forest land. The survey included all low-elevation grass, shrub, and juniper plant associations as well as grazeable forest land in the middle-elevation pine timber associations.

In order to maintain continuity between range data collected in the 1983 survey and the range sites identified and described in this survey, a special nomenclature was used in the section "Detailed Soil Map Units." Where applicable, the range site names from the 1983 survey are in parentheses following the new range site names. These are included at the end of each map unit description. By identifying both range site names in this report, previously mapped range sites can be compared and contrasted with the

potential native plant community identified in each of the current range site descriptions.

General Vegetation Zones

The general vegetation map at the back of this publication shows broad areas, or zones, that have distinctive patterns of native plant community types. The use of these zones permits a focus on geographical differences in climate and vegetation and the generalization of complex local vegetation patterns. The zones also provide a basis for broad management interpretations. The map should be used in conjunction with information in the sections "General Soil Map Units" and "Detailed Soil Map Units."

Vegetation zones may cover large geographical areas, but a single set of potential native plant communities is throughout the zone. Vegetative patterns usually are predictable within the zones, since they are related to local features, such as aspect, soils, and landforms. Macroclimate generally is relatively similar throughout a given zone. Climate and the associated landscapes and plant communities are expected to differ from zone to zone.

Forest Land Management and Productivity

By Craig M. Ziegler, area forester, Natural Resources Conservation Service.

The forest land in the survey area varies greatly. Not only do the tree species differ, but the soils, topography, and precipitation also differ. There are approximately 320,000 acres of commercial forest land, mainly in the western half of the survey area. The Mutton Mountains, which are in the northeastern part, also are forested. Precipitation in the forested areas ranges from 14 to 110 inches. The topography ranges from nearly level and gently sloping areas on the eastern edge of the forest land to very steep mountainsides in the western and southern parts of the forest land. The elevation ranges from 2,000 to 6,400 feet, which is at the timberline on Mt. Jefferson.

The principal forest cover is the interior ponderosa pine type. It is in the driest areas, which are mainly in the eastern, central, and southern parts of the forest land. It also is on south aspects at the higher elevations. Other species that are included in this cover type are Douglas fir, western larch, grand fir, incense cedar, and western juniper. At the middle elevations are the interior Douglas fir and grand fir cover types. Tree species of lesser extent in these types are ponderosa pine, lodgepole pine, western larch, and subalpine fir. Many cover types are at the higher elevations, but the coastal true fir/hemlock type is most common. The most prevalent species in this type are Pacific silver fir, noble fir, western hemlock, Douglas fir, and western white pine. Other cover types at high elevations include mountain hemlock, lodgepole pine, western hemlock, and Engelmann spruce/subalpine fir.

Many diseases and insects affect the forests, and they can be a problem in individual stands of trees. Damage can vary from year to year.

The western spruce budworm (*Choristoneura occidentalis*) defoliates Douglas fir, grand fir, noble fir, and Pacific silver fir. Occasional defoliation can reduce tree growth, but defoliation for 2 to 3 consecutive years can cause death. The mountain pine beetle (*Dendroctonus ponderosae*) commonly attacks all species of pine, and the western pine beetle (*Dendroctonus brevicomus*) commonly attacks ponderosa pine. These beetles can be a severe problem in overstocked stands of ponderosa pine and lodgepole pine. The larch casebearer (*Coleophora laricella*) attacks western larch, and the pine engraver beetle (*Ips pini*) commonly attacks ponderosa pine and occasionally other pines.

Dwarf mistletoe (*Arceuthobium spp.*) is a very destructive forest parasite that attacks western larch, ponderosa pine, lodgepole pine, Douglas fir, and western hemlock. This parasite lives off the host by absorbing food through roots that penetrate the bark of the tree. Laminated root rot (*Phellinus weirii*) commonly attacks Douglas fir, grand fir, noble fir, and mountain hemlock. It can be a severe problem in locally isolated areas of forest land. This root rot occasionally also attacks western hemlock, western larch, and Engelmann spruce. White pine blister rust (*Cronartium ribicola*) attacks western white pine, and western gall rust (*Endocronartium harknessii*) commonly attacks lodgepole pine and ponderosa pine. Armillaria rot (*Armillaria mellea*) and Indian paint fungus (*Echinodontium tinctorium*) commonly attack all species of pine.

Tables 7 and 8 provide important information to forest land managers as they seek ways to maximize the use of forest land. The information can be used to help make sound management decisions. Only the soils suitable for producing timber are listed in these tables.

In table 7, the *potential productivity* of *common trees* on a soil is expressed as a *site index*. This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedures for determining site index of various species are given in the site index publications used

for this survey (*1, 2, 6, 7, 8, 9, 10, 11, 13, 14, 17, 18, 24*). The site index applies to fully stocked, even-aged stands. The highest timber yields can be expected from areas that have the highest site indexes. Site index values can be converted into estimated yields at various ages by carefully using the appropriate yield tables.

Species preferred for wood production are those that are planted for reforestation or are allowed to regenerate naturally. The desired product, topographic position, and individual preference are only some of the factors that can influence the choice of adapted trees for reforestation.

Table 8 can serve as a quick reference for forest land interpretations. The soils are rated for a number of factors to be considered in woodland management. *Slight*, *moderate*, and *severe* indicate the degree of the major soil limitations. For each soil that has a rating of moderate or severe, additional information is given in the section "Detailed Soil Map Units."

Sheet and Rill Erosion

Definition. Sheet and rill erosion ratings refer to the risk of off-road soil loss after fire, grazing, or forest management activities that expose the soil.

Ratings. Slight indicates that no particular erosion control measures are needed under ordinary conditions, *moderate* indicates that some erosion control measures are needed, and *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Factors considered. Sheet and rill erosion ratings are determined by considering the amount and intensity of rainfall, the recovery rate of plant cover, soil erodibility (K factor), soil loss tolerance (T factor), and percent slope. Soil loss tolerance is defined as the maximum amount of erosion at which the quality of a soil as a medium for plant growth can be maintained.

Management implications. A rating of severe indicates the need for special harvesting systems or alternative site preparation techniques and proper timing.

Cut and Fill Erosion

Definition. Cut and fill erosion ratings refer to the risk that soil loss may occur from road cuts and fills. This rating does not consider dry ravel.

Ratings. Cuts and fills should be seeded. A rating of s*light* indicates that no other preventative measures are needed under ordinary conditions, *moderate* indicates that erosion control measures are needed under certain conditions, and *severe* indicates that erosion control practices are needed under most conditions.

Factors considered. The hazard of cut and fill erosion can be determined by considering the amount and intensity of rainfall, soil erodibility (K factor) of the exposed horizons, and angle and length of the slopes. The risk of erosion becomes greater as the length of cuts and fills and the weighted K factor value increase.

Management implications. Erosion control practices, such as seeding, mulching, and using sediment traps, may be needed.

Equipment Operability

Definition. Equipment operability ratings refer to the difficulty of using wheeled or tracked ground equipment because of certain soil, topographic, or climatic characteristics.

Ratings. Slight indicates that equipment use may be restricted because of wetness for a period of as long as 3 months in a normal year. The kind of equipment and season of use normally are not restricted because of site features. *Moderate* indicates that equipment use is limited because of one or more site features. Equipment use may be restricted by slope, stones, soil wetness, soil instability, extremes in soil texture (clayey or sandy), or a combination of two or more factors. Equipment use is restricted by soil wetness for a period of 3 to 6 months in a normal year. *Severe* indicates that the kind of equipment or the season of use is severely restricted because of one or more site features. Equipment use is restricted by soil wetness for a period of more than 6 months in a normal year.

Factors considered. Trafficability, soil-related physical impediments, steepness of slope, and soil wetness are the main factors that result in equipment limitations. As slope gradient and length increase, use of wheeled equipment becomes more difficult. Use of wheeled and tracked equipment is impractical on the steepest slopes. Soil wetness, especially in areas of fine-textured soils, can severely limit the use of equipment and make harvesting practical only during periods when the soils are dry or frozen. Extreme soil textures commonly affect the use of equipment. Organic soil, clay, and loose sand are subject to trafficability problems. Boulders and stones also may limit the use of equipment.

Management implications. Equipment operability limitations indicate a need for choosing the proper equipment and for properly timing operations to avoid seasonal limitations.

Soil Compaction

Definition. Soil compaction ratings refer to the risk that damage to the soil structure will occur as a result of equipment use during periods when the soils are wet or moist.

Ratings. Slight indicates that no special equipment is needed and the season of use generally is not restricted. *Moderate* indicates that there may be some seasonal restrictions on the use of ground equipment. Use of cable yarding systems may be advisable. *Severe* indicates the need for extreme caution. Some restorative practices, such as ripping or discing, may be needed following harvest activities.

Factors considered. Surface texture, coarse fragment content, and plasticity are soil characteristics considered in the compaction ratings. The ratings assume that the soil is wet or moist. Soil compaction decreases air spaces in the soil. Air and water movement thus are reduced, restricting root growth and increasing the risk of surface erosion.

Management implications. Compaction should be considered during silvicultural activities. Use of designated skid trails and protection of the duff layer are needed to minimize damage to the soil. A moderate or severe rating indicates the need to carefully choose the proper equipment and to be aware of seasonal limitations.

Soil Displacement

Definition. Soil displacement ratings refer tto the risk of gouging, scraping, or pushing soil from its natural position by mechanical means. It most often is associated with mechanical slash disposal, tractor yarding operations, and site preparation.

Ratings. Slight indicates that equipment use is not restricted. Special precautions generally are not needed. *Moderate* indicates that the use of specialized equipment, such as a brush rake, is needed for mechanical slash disposal, site preparation, and other activities that disturb the soil. *Severe* indicates that extreme caution is advised if practices that disturb the soil are used.

Factors considered. The texture of the surface layer and the amount of rock fragments in the upper 12 inches influence how readily the soil will hold together when pushed as a result of contact with machinery or logs. Slope is a factor because more maneuvering of machinery is needed in the steeper areas. Soil moisture is assumed to be at field capacity or drier.

Management implications. Restrictions on equipment use because of the soil displacement hazard indicate the need to closely monitor activities that disturb the soil, such as mechanical slash disposal and site preparation, or to use alternative methods. In areas where excessive soil displacement has occurred, plant recovery rates may be impaired. Prolonged exposure of bare soil may result in increased erosion and further deterioration of the site.

Seedling Mortality

Definition. Seedling mortality ratings refer to the risk of death of natural or planted tree seedlings as a result of soil or topographic characteristics. Plant competition and damage by animals are not considered in the ratings.

Ratings. The ratings apply to naturally occurring seedlings and to healthy, dormant bare-root or containerized seedlings from good stock that are properly planted during a period of sufficient moisture. *Slight* indicates that no problem is expected under normal conditions. *Moderate* indicates that some problems of mortality can be expected. Extra precautions are advised. *Severe* indicates that the rate of mortality will be high. Extra precautions are essential for successful reforestation.

Factors considered. Seedling mortality ratings are determined by the following factors.

- *Soil chemistry*. This influences the amount and kind of nutrients available to plants and affects the availability of water in the soil.
- *Soil drainage*. This indicates the degree, frequency, and duration of soil wetness.
- *Available water capacity*. The amount of water held in the soil for plant use is determined by the available water capacity and effective rooting depth of the soil. The amount of water held in the upper 20 inches is used as an indicator of droughtiness.
- *Temperature and moisture regime*. Seedlings can survive in areas that have a low available water capacity if the frequency and duration of rainfall are sufficient.
- *Slope and aspect*. Seedling mortality may be affected by the high temperatures and rate of evaporation associated with steep, south-facing slopes.

Management implications. To offset seedling mortality, it may be necessary to use larger than normal planting stock, special site preparation, surface drainage, or reinforcement plantings.

Windthrow

Definition. Windthrow ratings refer to the risk of trees being tipped over and partially or fully uprooted by strong winds during periods when the soil is moist or wet.

Ratings. Slight indicates that trees normally are not blown down by the wind. *Moderate* indicates that occasionally a tree may be blown down during periods when the soil is wet and the winds are moderate or strong. *Severe* indicates that many trees may be blown down during periods when the soil is wet and the winds are moderate or strong (see fig.13, page 99).

Factors considered. This rating considers the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. Rooting depth may be restricted because of a high water table, underlying bedrock, or an impervious layer. Loose soil may result in poor anchoring of roots.

Management implications. Moderate and severe ratings indicate the need for care in harvesting and thinning forest stands. Use of seed tree systems or regeneration with isolated single trees or groups of trees is not practical in areas that are subject to a moderate or severe windthrow hazard. Periodic salvage of windblown trees may be needed in these areas. Adequate road and trail systems are needed for salvage operations.

Plant Competition

Definition. Plant competition ratings refer to the likelihood of an invasion of plants sufficient to delay or prevent establishment of adapted tree seedlings.

Ratings. Slight indicates that competing vegetation will have little, if any, effect on the establishment and development of seedlings. *Moderate* indicates that uncontrolled competition from understory vegetation may retard natural or planted reforestation, but it will not prevent the eventual development of fully stocked stands. *Severe* indicates that uncontrolled competition from understory vegetation can be expected to prevent natural or planted reforestation.

Factors considered. Climate and soil characteristics can result in plant competition problems. Commonly, the key to predicting plant competition is the quantity and proximity of seed sources of undesirable plants or the quantity of unwanted brush rootstock that will resprout after harvesting.

Management implications. Moderate and severe ratings indicate the need for careful and thorough site preparation and the potential need for mechanical or chemical treatment to retard the growth of competing vegetation. Reforestation for tree crop production should be established before competing plants can invade.

Fire Damage

Definition. Fire damage ratings refer to the risk that a fire of moderate fireline intensity (116 to 520 btu's/sec/ft), which is likely in a clearcut slash burn, will have a negative impact on the nutrient content and the physical and biotic characteristics of the soil.

Ratings. Slight indicates that negative impacts to soil characteristics are not expected. *Moderate* indicates that negative impacts, such as nonwettability and excessive erosion, may occur. Extra caution is advised in planning prescribed fires. *Severe* indicates that negative impacts are likely to occur. Extreme caution is advised in planning prescribed fires.

Factors considered. Fire damage ratings are determined by the following factors.

- *Surface layer thickness*. Soils that have a shallow surface layer may not have the capacity to absorb the effects of fire and may be prone to slower recovery rates.
- *Slope*. The steeper slopes are more likely to erode if the protective layer of duff is burned off.
- *Soil texture and coarse fragment content*. Texture affects soil erodibility, plant recovery rates, and productivity. Coarse-textured soils transmit heat to a greater depth in a shorter period of time and are more prone to water repellency. Soils that have a high content of gravel or stones respond to fire similarly to coarse-textured soils. Medium-textured soils have a higher inherent available water capacity and are more likely to be cooler and more productive.
- *Organic matter content*. Soils that have an organic matter content of less than 2 percent usually are prone to slow recovery rates. Soils that have a high organic matter content generally are more resistant to sheet and rill erosion. These soils also have a higher available water capacity and are more likely to be cooler for longer periods during the year.

Management implications. Combustion of above- and below-ground organic matter volatilizes nutrients, reduces soil organic matter content, and in some soils increases water repellency. Populations of some soil organisms are at least temporarily reduced by the initial high soil temperatures during fire and by subsequent changes in the chemical and physical

properties of the soil. It may be necessary to consider use of winter burning and alternate lighting techniques, monitoring of the moisture content of fuel, yarding of unmerchantable material, elimination of prescribed burns, and use of erosion control measures following burning.

Recreation

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties generally are favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey; for example, interpretations for dwellings without basements and for local roads and streets in table 10 and interpretations for septic tank absorption fields in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

By Terry A. Luther, wildlife biologist, Confederated Tribes of the Warm Springs Reservation.

The soils in the survey area provide habitat for many kinds of fish and wildlife. The kinds and numbers of most wildlife species in the area are related to the kinds of soil. This relationship is influenced primarily by the kinds of plant communities, the topography, and the land use.

The general soil map units have been grouped according to their potential to provide similar kinds of wildlife habitat. These groups and the kinds of fish and wildlife present are described in the following paragraphs.

Group 1 (general soil map unit 1). This group consists of warm, dry soils on terraces and low foothills adjacent to the Deschutes and Warm Springs Rivers and the Dry, Shitike, and Tenino Creeks, at the eastern boundary of the survey area. The native vegetation is mainly basin wildrye, bluebunch wheatgrass, Sandberg bluegrass, basin big

sagebrush, and various forbs. The soils in this group are used for irrigated crops, livestock grazing, and homesite development. The riparian areas in this group along with adjacent areas of cropland provide the best habitat for wildlife habitat. Wildlife commonly found in areas of this group include California quail, ring-necked pheasant, mourning dove, waterfowl, beaver, and mink.

The Deschutes and Warm Springs Rivers and Shitike Creek provide important habitat for Chinook salmon, steelhead trout, bull trout, and rainbow trout.

The potential is good for improvement of the habitat in this group by using agricultural and herbaceous plantings and by properly managing existing riparian vegetation.

Group 2 (general soil map units 2, 3, and 4). This group consists of warm, dry soils on high foothills, in canyons, and on mesas on the eastern side of the survey area. The native vegetation is mainly bluebunch wheatgrass, Sandberg bluegrass, Wyoming big sagebrush, and various forbs. The soils in this group are used for livestock grazing, and they provide important forage for herds of deer that winter on the mesas and in the canyons adjacent to the Deschutes River. Other wildlife commonly found in areas of this group include chukar, badger, and coyote.

The Warm Springs River and Shitike Creek provide important habitat for Chinook salmon, steelhead trout, bull trout, and rainbow trout.

The potential is good for improvement of the habitat in this group by burning, seeding native or adapted plants, and properly managing existing vegetation.

Group 3 (general soil map units 5, 6, and 7). This group consists of warm, moist soils in canyons and on mesas on the eastern side of the survey area. The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, antelope bitterbrush, and various forbs. The soils in this group are used for livestock grazing, and they provide important forage for deer in winter. Other wildlife commonly found in areas of this group include badger, turkey, and coyote.

The Warm Springs River and Beaver, Mill, and Shitike Creeks provide important habitat for Chinook salmon, steelhead trout, bull trout, and rainbow trout.

The potential is good for improvement of the habitat by burning, seeding native or adapted plants, and properly managing existing vegetation.

Group 4 (general soil map unit 8). This group consists of warm, moist soils on outwash plains on Miller and Mill Creek Flats, in the central part of the survey area. The native vegetation is mainly bluebunch wheatgrass, Idaho fescue, antelope bitterbrush, buckwheat, ponderosa pine, and various forbs. The soils in this group are used for livestock grazing and timber production. They also provide important forage for deer in winter and for elk that winter in the Beaver Creek Prairie area. Other wildlife commonly found in areas of this group include badger, turkey, and coyote.

The Warm Springs River and Mill and Boulder Creeks provide important habitat for Chinook salmon, steelhead trout, bull trout, and rainbow trout.

The potential is good for improvement of the habitat by burning, seeding native or adapted plants, and properly managing existing vegetation.

Group 5 (general soil map units 9, 10, and 11). This group consists of warm, moist soils on foothills and mountains in the central and northeastern part of the survey area. The native vegetation is mainly Idaho fescue, antelope bitterbrush, common snowberry, ponderosa pine, Douglas fir, and various forbs. The soils in this group are used for livestock grazing and timber production. They also provide important forage for deer and elk in winter, and some areas provide important habitat for elk calving. Other wildlife commonly found in areas of this group include eagles, hawks, turkey, rabbits, grey squirrel, porcupine, black bear, cougar, and bobcat.

Boulder and Shitike Creeks provide important habitat for steelhead trout, bull trout, and rainbow trout.

The potential is good for improvement of the habitat by burning, seeding native or adapted plants, and properly managing existing vegetation. The habitat for big game can be improved by creating more dense stands of timber by removing fewer trees during thinning or by not thinning at all in some areas. The more dense stands provide escape and thermal cover for deer and elk. General soil map unit 10 also supports habitat that has the potential for reintroduction of desert bighorn sheep.

Group 6 (general soil map unit 12). This group consists of cool, moist soils at the lower elevations of the Cascade Mountains, on the western side of the survey area. The native vegetation is mainly Douglas fir, ponderosa pine, grand fir, snowbrush ceanothus, common snowberry, and various forbs. The soils in this group are used for timber production and wildlife habitat. They also provide important forage for deer and elk in mild winters. Stands of old-growth timber in this group provide critical habitat for the threatened northern spotted owl. Other wildlife commonly found in areas of this group include black bear, grey squirrel, and ruffed grouse.

The Warm Springs River and Mill Creek provide important habitat for spawning Chinook salmon and steelhead trout. A small area of this group at the southern end of the survey area, along Jefferson and Mariel Creeks and the Metolius River, provide important spawning habitat for kokanee salmon and bull trout. Badger, Boulder, Jefferson, and Shitike Creeks also provide habitat for rainbow trout.

The habitat for big game in this group can be improved by creating more dense stands of timber by removing fewer trees during thinning or by not thinning at all in some areas. The more dense stands provide escape and thermal cover for elk and deer.

Group 7 (general soil map unit 13). This group consists of cool, wet soils at the middle elevations of the Cascade Mountains, on the western side of the survey area. The native vegetation is mainly Douglas fir, western hemlock, Pacific silver fir, queencup beadlily, vine maple, and various forbs. The soils in this group are used for timber production and wildlife habitat. They also provide important summer forage for elk and deer and important habitat for elk calving. Stands of old-growth timber provide critical habitat for the threatened northern spotted owl. Other wildlife commonly found in areas of this group include black bear, pileated woodpecker, and blue grouse.

The Warm Springs River and Beaver Creek provide important spawning habitat for Chinook salmon and steelhead trout as well as habitat for bull trout and rainbow trout.

The habitat for big game can be improved by clearcutting in some areas, which provides excellent summer forage, and by creating dense stands of timber by removing fewer trees during thinning or not thinning at all in some areas. The dense stands provide escape and thermal cover for elk and deer.

Group 8 (general soil map units 14 and 15). This group consists of cold, wet soils at the high elevations of the Cascade Mountains, on the western boundary of the survey area. The native vegetation is mainly Douglas fir, western hemlock, mountain hemlock, lodgepole pine, common beargrass, big huckleberry, grouse blueberry, and Pacific rhododendron. This group provides important summer forage for elk and deer and important habitat for elk calving. Stands of old-growth timber in general soil map unit 14 also provide critical habitat for the threatened northern spotted owl. Other wildlife commonly found in areas of this group include black bear, cougar, pine martin, and snowshoe hare.

Trout Lake provides habitat for rainbow trout. Most of the other high mountain lakes provide habitat for brook trout.

The habitat for big game in general soil map unit 14 can be improved by clearcutting in some areas, which provides excellent summer forage, and by creating dense stands of timber by removing fewer trees during thinning or not thinning at all in some areas. The dense stands provide escape and thermal cover for elk and deer.

Native Food Plants

Native foods, including wild roots, fruits, stems, and leaves as well as fish and game, are an important part of the cultural life of the Warm Springs Tribes. Roots are dug from early in spring through late in summer. Fruit, especially huckleberries, is harvested in summer and fall.

The Warm Springs Tribes annually observe two religious feasts of thanksgiving—the Root Feast in spring and the Huckleberry Feast early in fall *(16)*—that are based on important native foods.

There are nine native food plants that are significant culturally to the Warm Springs Tribes. These include bitterroot, Canby's desert parsley, biscuitroot, blue camas, Indian carrot, wild celery, big huckleberry, chokecherry, and black lichen.

Bitterroot, also known as "Pe ah ke" or macaroni root, is the most popular root. Bitterroot is cooked in water similar to potatoes or served fresh with salmon. This plant grows in dry, rocky places and commonly is on the Bakeoven soils.

Canby's desert parsley, or "Luksh," is a variety of biscuitroot. It is cooked fresh or is dried and pounded into meal for use in "palm" cakes. This plant grows on dry, rocky hillsides and flats and commonly is on the Bakeoven and Rockly soils.

Biscuitroot, also known as "Coush" or bread root, is the most abundant root harvested in the survey area. It is cooked fresh or is chopped, dried, and stored for later use. The small, dry pellets are used in soups or meat broths and provide a slight thickening similar to potatoes or meal. This plant grows on dry, rocky hillsides and flats and commonly is on the Bakeoven and Rockly soils.

Blue camas, or "Wa ka mo," grows in damp places. The blue blossoms must be observable at the time of harvest to avoid selecting the deadly white-flowering death camas. Blue camas should be peeled, and it can be eaten fresh or dried in the sun for year-round use. Frequently, dried camas is cooked with dried biscuitroot. Camas most commonly is in meadows of the ponderosa pine zone, in areas associated with the Dahl, Kahneeta, and Olallie soils.

Indian carrot, also known as “Saw-wictk” or wild carrot, is eaten raw or cooked when fresh. It also is dried and pounded into meal for use in “palm” cakes. This plant is in meadows of the ponderosa pine zone, in areas associated with the Dahl, Kahneeta, and Logsprings soils.

Wild celery, or “Cum-see,” is not preserved in any way. The stem is eaten fresh during the season, which usually lasts from April through June. This plant commonly is on hillsides and meadows of the ponderosa pine zone, in areas associated with the Logsprings and Dahl soils.

Big huckleberries, or “We Woo no Wash,” are important in the rituals and festivals of the Warm Springs Tribes and are used fairly regularly in their diet. In season, they are eaten fresh. They also are canned, frozen, sun dried, or barbecued for use during the rest of the year. This plant is in areas of the Jojo and Pinhead soils, from Olallie Butte north to the survey area boundary. It is most abundant in forests that have an open canopy.

Chokecherries, or “T-mish,” can be eaten fresh in season, which is during August, but most are preserved for later use. Chokecherries are not very abundant in the survey area, and they usually are associated with soils along drainageways, such as those of the Millerflat series and Vitrandic Haploxerolls and Xerofluvents.

Black lichen, or “Koonts,” is differentiated from other lichens by it hairy characteristic. It is soaked in water, cooked in a pit, and cut into small bars that are frozen or are ground and dried. The bars are cooked in water with a little flour and sugar and eaten as a dessert. Black lichen grows on fir, pine, and juniper trees and most commonly is near Simnasho Butte. Because of the way it grows, it cannot be correlated to any particular soil type.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the “Soil Properties” section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the “Glossary.”

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills generally are limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to

a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage because of rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed

that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel, or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the taxonomic unit descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a *probable* source has a layer of clean sand or gravel or a layer of sand or gravel that is as much as 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an *improbable* source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils generally is preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or

site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bed rock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features listed in tables are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 to 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each taxonomic unit under the heading "Taxonomic Units and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added; for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(4)* and the system adopted by the American Association of State Highway and Transportation Officials *(3)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification; for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area

and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each taxonomic unit under the heading "Taxonomic Units and Their Morphology."

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields and in construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The

change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. *Very high,* more than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, very fine sand, sand, and organic matter (as much as 4 percent) and on soil structure and permeability. The estimates are modified by the presence of rock fragments. Values of K range from 0.02 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion.

Erosion factor T is an estimate of the maximum average rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the amount of stable aggregates 0.84 millimeters in size. These are represented idealistically by USDA textural classes. Soils containing rock fragments can occur in any group.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Tables 16 gives estimates of various water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sand or gravelly sand. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay that has high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Shallow water standing for short periods after rainfall or snowmelt is not considered to be flooding. Standing water in swamps and marshes or in closed depressional areas is considered to be ponding rather than flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur. Frequency, duration, and probable dates of occurrence are estimated. *Frequency* is expressed as none, rare, occasional, or frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 0 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year).

Duration is expressed as *very brief* (less than 2 days), *brief* (2 to 7 days), *long* (7 days to 1 month), and *very long* (more than 1 month). The time of year that flooding is most likely to occur is expressed in months. November-May, for example, means that flooding can occur during the period November through May. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay

deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons, which is characteristic of soils that are not subject to flooding.

Also considered are local information about the extent and level of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth given applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table usually is highest. A water table that is seasonally high for less than 1 month is not indicated in the table.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An *artesian* water table is under hydrostatic head, generally below an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower water table by a dry zone.

The two numbers in the column showing depth to the water table indicate the normal range in depth to a saturated zone. Depth is given to the nearest half foot. The first numeral in the range indicates the highest water level. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. "More than 6.0" indicates that the water table is below a depth of 6 feet or that it is within a depth of 6 feet for less than a month.

Table 17 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

A *cemented pan* is a cemented or indurated subsurface layer at a depth of 5 feet or less. Such a pan causes difficulty in excavation. Pans are classified as thin or thick. A *thin* pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A *thick* pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(19)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Xeroll (*Xer*, meaning xeric moisture regime, plus *oll*, from Mollisol).

GREAT GROUP Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploxerolls (*Hapl*, meaning minimal horizonation, plus *xerolls*, the suborder of the Mollisols that have a xeric moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haploxerolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, thickness of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is loamy-skeletal, mixed, mesic Typic Haploxerolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Taxonomic Units and Their Morphology

In this section, each taxonomic unit recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each unit. A pedon, a small three-dimensional area of soil, that is typical of the unit in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (20)*. Many of the technical terms used in the descriptions are defined in *Keys to Soil Taxonomy (19)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the unit.

The map units of each taxonomic unit are described in the section “Detailed Soil Map Units.”

Allingham Series

The Allingham series consists of very deep, well drained soils on stream terraces. These soils formed in mixed alluvium and glacial outwash with a mantle of

volcanic ash. Slopes are 0 to 3 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Allingham sandy loam, 0 to 3 percent slopes, in an area of woodland; 2,500 feet east and 1,500 feet north of the southwest corner of sec. 34, T. 11 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.
A1—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; moderate medium platy structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots and common coarse roots; many very fine, fine, and medium irregular pores and common coarse irregular pores; 5 percent gravel; moderately acid (pH 6.0); clear smooth boundary.
A2—4 to 15 inches; dark brown (10YR 3/3) sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure parting to weak thin platy structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
2Bwb1—15 to 22 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
2Bwb2—22 to 33 inches; dark yellowish brown (10YR 4/4) gravelly loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many iron and manganese coatings on peds; 15 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
3Btb—33 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly clay loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 30 percent gravel and 10 percent cobbles; slightly acid (pH 6.2).

Depth to bedrock is more than 60 inches. Depth to glacial outwash is 20 to 40 inches. The umbric epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist and 2 to 4 dry. It is 0 to 10 percent gravel.

The 2Bwb horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 5 to 15 percent gravel.

The 3Btb horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 4 or 5 moist or dry. It is clay loam or loam and is 30 to 40 percent gravel and 10 to 20 percent cobbles.

Antoken Series

The Antoken series consists of very deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 2 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Antoken extremely cobbly silt loam in an area of Simas-Antoken complex, 2 to 30 percent slopes, in an area of rangeland; 2,500 feet east and 1,000 feet north of the southwest corner of sec. 10, T. 8 S., R. 13 E.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) extremely cobbly silt loam, grayish brown (10YR 5/2) dry; moderate medium platy structure parting to moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 50 percent cobbles and 15 percent gravel; neutral (pH 6.8); clear smooth boundary.
AB—6 to 10 inches; very dark grayish brown (10YR 3/2) very cobbly silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 40 percent cobbles and 10 percent gravel; neutral (pH 7.2); abrupt smooth boundary.
2Bt1—10 to 17 inches; dark brown (7.5YR 3/2) very cobbly clay, brown (7.5YR 4/2) dry; strong

medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores and few medium and coarse tubular pores; common prominent clay films on faces of peds and lining pores; 25 percent cobbles and 10 percent gravel; neutral (pH 7.2); clear smooth boundary.

2Bt2—17 to 22 inches; dark brown (7.5YR 4/4) very cobbly silty clay, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium and coarse tubular pores; common prominent clay films on faces of peds and lining pores; 25 percent cobbles and 10 percent gravel; neutral (pH 7.4); clear smooth boundary.

2Btk—22 to 30 inches; brown (7.5YR 5/4) very cobbly silty clay, reddish yellow (7.5YR 6/6) dry; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine and fine roots; few very fine and fine tubular pores; few distinct clay films on faces of peds; slightly effervescent; 35 percent cobbles and 15 percent gravel; moderately alkaline (pH 8.0); clear smooth boundary.

3Bk1—30 to 38 inches; brown (7.5YR 5/4) extremely cobbly loam, pinkish gray (7.5YR 7/2) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; violently effervescent with soft masses of secondary lime; 40 percent cobbles, 15 percent stones, and 15 percent gravel; moderately alkaline (pH 8.4); gradual smooth boundary.

3Bk2—38 to 60 inches; light brown (7.5YR 6/4) extremely stony sandy loam, pinkish white (7.5YR 8/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; violently effervescent with soft masses of secondary lime; 25 percent stones, 40 percent cobbles, and 15 percent gravel; moderately alkaline (pH 8.4).

Depth to bedrock and depth of the solum are more than 60 inches. The mollic epipedon is 10 to 20 inches thick. Depth to secondary calcium carbonates is 20 to 30 inches. The particle-size control section is 50 to 60 percent clay and 35 to 50 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 50 to 60 percent cobbles and 10 to 20 percent gravel. The horizon is slightly acid or neutral.

The AB horizon has color similar to that of the A horizon. The AB horizon is very cobbly silty clay loam or extremely cobbly silt loam. It is 40 to 50 percent cobbles and 10 to 20 percent gravel. The horizon is slightly acid or neutral.

The 2Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It is silty clay or clay. It is 25 to 35 percent cobbles, 10 to 20 percent gravel, and 0 to 5 percent stones. The 2Bt horizon is neutral to moderately alkaline.

The 3Bk horizon has value of 5 or 6 moist and 7 or 8 dry, and it has chroma of 2 to 4 moist or dry. It is strongly effervescent or violently effervescent and has 5 to 10 percent calcium carbonate equivalent. It is 30 to 40 percent cobbles, 15 to 25 percent stones, and 15 to 20 percent gravel.

Aridic Haploxerolls

Aridic Haploxerolls are very deep, well drained soils on terrace escarpments. These soils formed in medium- to coarse-textured alluvium derived from mixed sources with an influence of volcanic ash. Slopes are 30 to 80 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Reference pedon of Aridic Haploxerolls, 30 to 80 percent slopes; 2,500 feet south and 1,000 feet east of the northwest corner of sec. 30, T. 9 S., R. 12 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) very stony loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 20 percent cobbles, 20 percent gravel, and 10 percent stones; neutral (pH 7.0); clear smooth boundary.

A2—10 to 17 inches; dark brown (10YR 3/3) very cobbly loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure parting to weak fine granular structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent cobbles, 20 percent gravel, and 5 percent stones; neutral (pH 7.2); clear smooth boundary.

2C1—17 to 33 inches; dark brown (10YR 3/3) extremely gravelly sandy loam, brown (10YR 5/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 40

percent gravel, 10 percent cobbles, and 10 percent stones; mildly alkaline (pH 7.4); abrupt smooth boundary.

2C2—33 to 38 inches; dark brown (10YR 3/3) extremely gravelly sandy clay loam, brown (10YR 5/3) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 50 percent gravel and 20 percent cobbles; mildly alkaline (pH 7.4); clear wavy boundary.

2C3—38 to 60 inches; dark brown (10YR 4/3) extremely gravelly sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; 50 percent gravel and 20 percent cobbles; neutral (pH 7.2).

Depth to waterlain sediment or paralithic volcanic tuff of the Deschutes Formation is more than 60 inches. Depth to the 2C horizon ranges from 15 to 40 inches or more. The profile has mollic colors to a depth of 38 inches, but the organic carbon content is less than 0.6 percent below a depth of 17 inches.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It typically is very stony loam. It is 15 to 50 percent gravel, 20 to 40 percent cobbles, and 10 to 20 percent stones.

The 2C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. The upper part is sandy clay loam or sandy loam, and the lower part is sandy loam or loamy sand. The horizon is 30 to 60 percent gravel, 10 to 30 percent cobbles, and 0 to 10 percent stones.

Axford Series

The Axford series consists of deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 2 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Axford silt loam in an area of Walsey-Axford complex, 30 to 55 percent slopes, in an area of rangeland; 2,050 feet north and 3,000 feet east of the southwest corner of sec. 11, T. 8 S., R. 13 E.

A1—0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 5 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

AB—5 to 11 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 5 percent gravel; neutral (pH 6.6); clear smooth boundary.

Bt1—11 to 15 inches; dark brown (10YR 3/3) clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; common distinct clay films on faces of peds; 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.

Bt2—15 to 24 inches; dark brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; common distinct clay films on faces of peds; 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

2Bk1—24 to 33 inches; yellowish brown (10YR 5/4) silt loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; few faint clay films on faces of peds; slightly effervescent; soft masses of segregated lime in blotches; 10 percent gravel; moderately alkaline (pH 8.0); clear smooth boundary.

2Bk2—33 to 46 inches; brown (10YR 4/3) gravelly silt loam, very pale brown (10YR 7/3) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; strongly effervescent; soft masses of segregated lime in blotches; 10 percent cobbles and 20 percent gravel; moderately alkaline (pH 8.4); gradual smooth boundary.

2Cr—46 inches; weathered basalt; violently effervescent with disseminated lime in fractures.

Depth to bedrock is 40 to 60 inches. The mollic epipedon is 10 to 20 inches thick. Depth to secondary carbonates is 20 to 30 inches. The particle-size control section averages 27 to 35 percent clay and 15 to 30 percent fine sand or coarser material.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 0 to 10 percent gravel. The horizon is slightly acid or neutral.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is silty clay loam or clay loam and is 0 to 10 percent gravel and 0 to 5 percent cobbles. The Bt horizon is neutral or mildly alkaline.

The 2Bk horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is loam, gravelly loam, or silt loam and is 10 to 20 percent gravel and 0 to 10 percent cobbles. It is slightly effervescent to strongly effervescent and is moderately alkaline or strongly alkaline.

Bakeoven Series

The Bakeoven series consists of very shallow, well drained soils on mesas. These soils formed in residuum and colluvium derived dominantly from basalt. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Bakeoven very cobbly loam, 2 to 15 percent slopes; 2,000 feet north and 500 west of the southeast corner of sec. 20, T. 6 S., R. 13 E.

A—0 to 3 inches; very dark brown (10YR 2/2) very cobbly loam, grayish brown (10YR 5/2) dry; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; 35 percent cobbles and 15 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

BA—3 to 6 inches; very dark grayish brown (10YR 3/2) very cobbly loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium tubular pores; 40 percent cobbles and 15 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bw—6 to 9 inches; dark brown (10YR 3/3) extremely cobbly clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; few faint discontinuous clay films on faces of rock fragments; 50 percent cobbles and 25 percent gravel; neutral (pH 6.6); abrupt smooth boundary.

R—9 inches; basalt.

Depth to bedrock is 6 to 10 inches. The particle-size control section averages 20 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is very cobbly loam, extremely gravelly loam, or extremely stony loam and is 0 to 30 percent stones, 20 to 40 percent cobbles, and 10 to 50 percent gravel.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 3 or 4 moist or dry. It is loam or clay loam. It is 30 to 50 percent cobbles and 15 to 30 percent gravel.

Belrick Series

The Belrick series consists of very deep, somewhat excessively drained soils on glacial moraines. These soils formed in glacial till and volcanic ash. Slopes are 0 to 30 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 41 degrees F.

Typical pedon of Belrick fine sandy loam in an area of Douthit-Belrick complex, 12 to 30 percent slopes, in an area of woodland; 2,500 feet west and 400 feet north of the southeast corner of sec. 31, T. 10 S., R. 9 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 5 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

A2—5 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

2C1—15 to 25 inches; dark brown (10YR 3/3) cobbly fine sandy loam, yellowish brown (10YR 5/6) dry; massive; soft, very friable, nonsticky and

nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 10 percent cobbles and 10 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
2C2—25 to 37 inches; dark brown (10YR 3/3) cobbly fine sandy loam, yellowish brown (10YR 5/6) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 10 percent cobbles and 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
3Bwb—37 to 48 inches; dark brown (10YR 3/3) very stony sandy loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 30 percent stones, 20 percent cobbles, and 10 percent gravel; slightly acid (pH 6.2); gradual smooth boundary.
3C1—48 to 58 inches; dark brown (10YR 3/3) extremely stony sand, pale brown (10YR 6/3) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 30 percent stones, 30 percent cobbles, and 10 percent gravel; slightly acid (pH 6.2); clear wavy boundary.
3C2—58 to 65 inches; dark gray (10YR 4/1) extremely stony sand, gray (10YR 6/1) dry; single grain; loose, nonsticky and nonplastic; 40 percent cobbles, 20 percent stones, and 10 percent gravel; slightly acid (pH 6.2).

Depth to bedrock is more than 60 inches. Depth to buried glacial till is 20 to 40 inches. The particle-size control section averages 10 to 15 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist and 3 or 4 dry. It is 0 to 10 percent gravel.

The 2C horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist and 4 to 6 dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles.

The 3Bwb horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 20 to 30 percent cobbles, 15 to 30 percent stones, and 10 to 20 percent gravel.

The 3C horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 1 to 4 moist or dry. It is 20 to 40 percent cobbles, 15 to 30 percent stones, and 10 to 20 percent gravel.

The Belrick soils in this survey area are a taxadjunct to the Belrick series because they have a slightly warmer mean summer soil temperature. This difference, however, does not significantly affect use and management.

Bluesters Series

The Bluesters series consists of very deep, excessively drained soils on cinder cones. These soils formed in volcanic ash and cinders. Slopes are 15 to 40 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Bluesters gravelly sandy loam, 15 to 40 percent slopes, in an area of woodland; 1,000 feet west and 1,200 feet south of the northeast corner of sec. 9, T. 8 S., R. 9 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A1—0 to 4 inches; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine, fine, and medium irregular pores; 25 percent gravel-sized cinders and 10 percent cinders that are 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.
A2—4 to 10 inches; dark brown (7.5YR 3/3) gravelly sandy loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 30 percent gravel-sized cinders and 10 percent cinders that are 0.5 to 2.0 millimeters in diameter; neutral (pH 6.8); clear smooth boundary.
C—10 to 18 inches; dark reddish brown (5YR 3/4) gravelly sandy loam, reddish brown (5YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; common fine and medium tubular pores; 30 percent gravel-sized cinders and 15 percent cinders that are 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.
2C—18 to 60 inches; reddish brown (5YR 4/4) cinders, light reddish brown (5YR 6/4) dry; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; many fine vesicular pores; neutral (pH 6.6).

Depth to bedrock is more than 60 inches. Depth to cinders is 15 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is 20 to 30 percent

basaltic gravel-sized cinders and 10 to 20 percent cinders that are 0.5 to 2.0 millimeters in diameter.

The C horizon has hue of 7.5YR or 5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is 25 to 35 percent basaltic gravel-sized cinders and 10 to 20 percent cinders that are 0.5 to 2.0 millimeters in diameter.

The 2C horizon has hue of 7.5YR or 5YR, value of 4 to 7 moist or dry, and chroma of 4 to 8 moist or dry. It is 80 to 95 percent basaltic gravel-sized cinders.

Boardflower Series

The Boardflower series consists of very deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash in the upper part. Slopes are 2 to 20 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Boardflower loam, 2 to 20 percent slopes, in an area of woodland; 600 feet east and 2,000 feet north of the southwest corner of sec. 26, T. 6 S., R. 11 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A—0 to 8 inches; dark brown (7.5YR 3/3) loam, light brown (7.5YR 6/3) dry; moderate medium platy structure parting to moderate medium granular; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 5 percent gravel; slightly acid (pH 6.3); gradual smooth boundary.

BA—8 to 25 inches; dark brown (7.5YR 3/4) loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 5 percent gravel; slightly acid (pH 6.4); gradual smooth boundary.

Bt1—25 to 34 inches; dark brown (7.5YR 3/4) clay loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common very fine, fine, and medium roots and few coarse roots; common very fine and fine tubular pores and few medium tubular pores; common distinct clay films on faces of peds and lining pores; 10 percent gravel; slightly acid (pH 6.4); abrupt smooth boundary.

2Bt2—34 to 60 inches; dark brown (7.5YR 3/4) clay, light brown (7.5YR 6/4) dry; weak medium and coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few very fine, fine, medium, and coarse roots along faces of peds; few very fine, fine, and medium tubular pores; continuous prominent clay films on faces of peds and lining pores; neutral (pH 7.0).

Depth to sedimentary rock is more than 60 inches. Depth to the discontinuity is 25 to 35 inches. The lower part of the particle-size control section averages 35 to 45 percent clay and 0 to 10 percent gravel. The profile has hue of 10YR or 7.5YR.

The A horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel.

The BA horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is 15 to 25 percent clay and 0 to 10 percent gravel.

The Bt1 horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is clay loam or silty clay loam and is 30 to 40 percent clay and 0 to 10 percent gravel.

The 2Bt2 horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is clay or silty clay and is 40 to 50 percent clay and 0 to 5 percent gravel.

Bodell Series

The Bodell series consists of shallow, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from basalt with an influence of volcanic ash in the upper part. Slopes are 0 to 55 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Bodell very cobbly loam, 30 to 55 percent slopes; 1,200 feet west and 600 south of the northeast corner of sec. 3, T. 6 S., R. 11 E.

A—0 to 4 inches; dark brown (7.5YR 3/2) very cobbly loam, brown (7.5YR 5/2) dry; weak fine and medium granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 20 percent cobbles and 20 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bw1—4 to 10 inches; dark brown (7.5YR 3/2) very gravelly loam, brown (7.5YR 5/2) dry; moderate medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores;

30 percent gravel and 10 percent cobbles; neutral (pH 6.8); clear smooth boundary.
Bw2—10 to 14 inches; dark brown (7.5YR 3/3) extremely gravelly clay loam, brown (7.5YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; 50 percent gravel and 10 percent cobbles; neutral (pH 6.6); abrupt wavy boundary.
2R—14 inches; basalt.

Depth to bedrock is 12 to 20 inches. The particle-size control section averages 18 to 30 percent clay. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is very cobbly loam or very stony loam and is 10 to 30 percent gravel, 10 to 30 percent cobbles, and 0 to 35 percent stones.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 10 to 60 percent gravel, 10 to 55 percent cobbles, and 0 to 15 percent stones.

Booten Series

The Booten series consists of very deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from volcanic ash and pumice. Slopes are 0 to 65 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Booten loam, 0 to 12 percent slopes, in an area of woodland; 1,200 feet west and 2,300 feet south of the northeast corner of sec. 10, T. 10 S., R. 11 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A1—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine and medium granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; common very fine, fine, and medium irregular pores; 5 percent gravel-sized pumice; slightly acid (pH 6.2); clear smooth boundary.
A2—6 to 13 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots and common coarse roots; many very fine, fine, and medium tubular pores; 5 percent gravel-sized pumice; slightly acid (pH 6.4); clear smooth boundary.
Bt1—13 to 23 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and few coarse roots; many very fine, fine, and medium tubular pores; few distinct clay films on faces of peds; 5 percent gravel-sized pumice; slightly acid (pH 6.4); clear smooth boundary.
Bt2—23 to 30 inches; brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores and few medium and coarse tubular pores; few distinct clay films on faces of peds; 15 percent gravel-sized pumice; neutral (pH 6.6); clear smooth boundary.
Bt3—30 to 44 inches; dark grayish brown (10YR 4/2) gravelly clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; common distinct clay films on faces of peds; 30 percent gravel-sized pumice; neutral (pH 6.8); clear smooth boundary.
C—44 to 60 inches; brown (10YR 4/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, firm, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 65 percent gravel-sized pumice; neutral (pH 6.8)

Depth to the bedrock is more than 60 inches. The mollic epipedon is 10 to 15 inches thick. The particle-size control section is 18 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel-sized pumice and 10 to 20 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is loam, clay loam, or sandy clay loam and is 5 to 35 percent gravel-sized pumice. It is slightly acid or neutral.

The C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is sandy loam or loam and is 40 to 70 percent gravel-sized pumice. It is slightly acid or neutral.

Dahl Series

The Dahl series consists of very deep, moderately well drained soils in basins. These soils formed in mixed alluvium and colluvium derived dominantly from sedimentary rock. Slopes are 0 to 3 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Dahl silty clay, 0 to 3 percent slopes, in an area of rangeland; 400 feet south and 300 feet east of the northwest corner of sec. 23, T. 6 S., R. 11 E.

A—0 to 3 inches; dark gray (10YR 4/1) silty clay, grayish brown (10YR 5/2) dry; strong thick platy structure; hard, firm, sticky and plastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; neutral (pH 7.0); clear smooth boundary.

Bss1—3 to 20 inches; dark gray (10YR 4/1) silty clay, grayish brown (10YR 5/2) dry; strong coarse prismatic structure; extremely hard, extremely firm, very sticky and very plastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; many intersecting slickensides; neutral (pH 7.0); clear smooth boundary.

Bss2—20 to 27 inches; dark grayish brown (10YR 4/2) clay, brown (10YR 5/3) dry; strong coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; many very fine and fine roots and few medium roots; many very fine, fine, and medium tubular pores; many intersecting slickensides; neutral (pH 7.0); clear smooth boundary.

Bss3—27 to 35 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, very firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many intersecting slickensides; neutral (pH 7.2); clear smooth boundary.

2Bw—35 to 45 inches; brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; mildly alkaline (pH 7.4) clear smooth boundary.

3Bkss—45 to 60 inches; brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; common faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common intersecting slickensides; strongly effervescent with segregated lime in seams; moderately alkaline (pH 7.9).

Depth to sedimentary rock is more than 60 inches. Depth to the 3Bkss horizon is 40 to 55 inches. The particle-size control section averages 35 to 55 percent clay.

The A horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 1 or 2 moist or dry.

The Bss horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 1 to 3 moist or dry. It is silty clay or clay.

The 2Bw horizon has value of 5 or 6 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam or loam.

The 3Bkss horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is mildly alkaline or moderately alkaline.

Day Series

The Day series consists of very deep, well drained soils on foothills. These soils formed in residuum and colluvium derived dominantly from sedimentary rock. Slopes are 0 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Day clay in an area of Day complex, 8 to 40 percent slopes, in an area of rangeland; 4,000 feet north and 4,050 feet west of the southeast corner of sec. 10, T. 8 S., R. 13 E.

A—0 to 8 inches; dark red (2.5YR 3/6) clay, dark reddish brown (2.5YR 3/4) dry; moderate medium subangular blocky structure parting to strong thick platy; hard, firm, very sticky and very plastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; mildly alkaline (pH 7.6); gradual wavy boundary.

AB—8 to 16 inches; dark red (2.5YR 3/6) clay, dark reddish brown (2.5YR 3/4) dry; weak coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine tubular pores; mildly alkaline (pH 7.6); clear smooth boundary.

ABkss—16 to 39 inches; dark red (2.5YR 3/6) clay, dark reddish brown (2.5YR 3/4) dry; weak coarse prismatic structure; very hard, very firm, very

sticky and very plastic; few very fine, fine, and medium roots; few very fine and fine tubular pores; many intersecting slickensides; slightly effervescent; few very fine blotches of segregated lime; moderately alkaline (pH 8.0); clear smooth boundary.

Bkss—39 to 49 inches; dark red (2.5YR 3/6) clay, dark reddish brown (2.5YR 3/4) dry; massive; hard, firm, sticky and plastic; common intersecting slickensides; few very fine roots; few very fine tubular pores; strongly effervescent; few very fine blotches of segregated lime; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—49 to 60 inches; red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) dry; massive; hard, firm, sticky and plastic; strongly effervescent; common very fine blotches of segregated lime; moderately alkaline (pH 8.4).

Depth to bedrock is more than 60 inches. The profile has hue of 10R to 5YR. The particle-size control section averages 60 to 70 percent clay.

The A horizon has value of 2 or 3 moist and 3 to 5 dry, and it has chroma of 3 to 6 moist or dry. It is silty clay loam, silty clay, or clay and is 0 to 30 percent stones and 0 to 20 percent cobbles.

The AB horizon has value of 3 or 4 moist or dry and chroma of 3 to 6 moist or dry. It is mildly alkaline to strongly alkaline.

The Bk horizon has value of 3 or 4 moist or dry and chroma of 4 to 6 moist or dry. It is clay, clay loam, or silty clay loam.

Douthit Series

The Douthit series consists of very deep, somewhat excessively drained soils on glacial moraines. These soils formed in glacial till and volcanic ash. Slopes are 0 to 65 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 41 degrees F.

Typical pedon of Douthit very cobbly sandy loam in an area of Douthit-Belrick complex, 12 to 30 percent slopes, in an area of woodland; 2,200 feet west and 500 feet north of the southeast corner of sec. 31, T. 10 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 5 inches; dark brown (7.5YR 3/2) very cobbly sandy loam, dark yellowish brown (10YR 4/4) dry; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 20 percent gravel, 10 percent cobbles, and 5 percent stones; moderately acid (pH 6.0); clear smooth boundary.

A2—5 to 16 inches; dark brown (7.5YR 3/2) very cobbly sandy loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 25 percent gravel and 15 percent cobbles; moderately acid (pH 6.0); clear wavy boundary.

2C1—16 to 26 inches; dark brown (7.5YR 3/3) extremely stony sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 30 percent stones, 20 percent cobbles, and 20 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

2C2—26 to 49 inches; dark brown (7.5YR 3/3) extremely stony sandy loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 30 percent stones, 30 percent cobbles, and 20 percent gravel; slightly acid (pH 6.2); clear wavy boundary.

3C3—49 to 60 inches; brown (10YR 4/3) extremely cobbly loamy sand, light yellowish brown (10YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; 40 percent cobbles, 20 percent gravel, and 10 percent stones; moderately acid (pH 5.8);

Depth to bedrock is more than 60 inches. The particle-size control section averages 10 to 15 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist and 3 or 4 dry. It is very cobbly sandy loam or very stony sandy loam and is 15 to 25 percent gravel, 10 to 20 percent cobbles, and 0 to 30 percent stones.

The 2C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 20 to 30 percent stones, 20 to 35 percent cobbles, and 10 to 20 percent gravel.

The 3C horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is loamy sand or sand and is 30 to 50 percent cobbles, 10 to 30 percent stones, and 10 to 20 percent gravel.

The Douthit soils in this survey area are a taxadjunct to the Douthit series because they have a slightly warmer mean summer soil temperature. This

difference, however, does not significantly affect use and management.

Drybed Series

The Drybed series consists of very deep, well drained soils on stream terraces. These soils formed in alluvium derived from mixed sources with an influence of loess in the upper part. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Drybed silt loam, 0 to 8 percent slopes, in an area of rangeland; 500 feet west and 1,500 feet south of the northeast corner of sec. 18, T. 9 S., R. 13 E.

A1—0 to 4 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; moderate thin platy structure; soft, friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium irregular pores; 3 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

A2—4 to 13 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate thick platy structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 3 percent gravel; mildly alkaline (pH 7.6); clear smooth boundary.

Btk1—13 to 22 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and plastic; few very fine and fine roots; common very fine and fine tubular pores; common faint clay films on faces of peds; slightly effervescent with segregated lime in filaments or threads; 3 percent gravel; moderately alkaline (pH 8.4); clear smooth boundary.

Btk2—22 to 29 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; strongly effervescent with segregated lime in seams; 3 percent gravel; strongly alkaline (pH 8.8); clear smooth boundary.

2Ck1—29 to 40 inches; brown (10YR 4/3) sandy clay loam, light gray (10YR 7/2) dry; massive; very hard, very firm, slightly sticky and slightly plastic; violently effervescent with segregated lime in blotches; 3 percent gravel; strongly alkaline (pH 8.8); gradual smooth boundary.

2Ck2—40 to 60 inches; dark yellowish brown (10YR 4/4) sandy clay loam, light gray (10YR 7/2) dry; massive; hard, firm, nonsticky and nonplastic; violently effervescent with disseminated lime and segregated lime in blotches; 3 percent gravel; moderately alkaline (pH 8.4).

Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 15 inches thick. Depth to secondary carbonates is 10 to 20 inches. The particle-size control section averages 27 to 35 percent clay and 15 to 30 percent fine sand and coarser material.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 0 to 5 percent gravel and 1 to 2 percent organic matter.

The Btk horizon has value of 2 to 4 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam and is 0 to 5 percent gravel and less than 1 percent organic matter.

The 2Ck horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 2 to 4 moist or dry. It is sandy clay loam or loam and is 0 to 5 percent gravel.

Dryhollow Series

The Dryhollow series consists of very deep, well drained soils in canyons. These formed in residuum and colluvium derived dominantly from volcanic ash and pumice. Slopes are 0 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Dryhollow loam, 12 to 30 percent slopes, in an area of rangeland; 1,800 feet west and 400 feet north of the southeast corner of sec. 16, T. 11 S., R. 12 E.

A—0 to 3 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 5 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 7.0); clear smooth boundary.

BA—3 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular

pores and few medium tubular pores; 10 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 7.2); clear smooth boundary.

Bw1—11 to 20 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium and coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 10 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 7.2); clear smooth boundary.

Bw2—20 to 35 inches; dark brown (10YR 3/3) cobbly sandy loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 10 percent cobbles, 10 percent gravel-sized pumice, and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; mildly alkaline (pH 7.4); clear smooth boundary.

C1—35 to 47 inches; brown (10YR 4/3) gravelly loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 25 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; mildly alkaline (pH 7.4); gradual smooth boundary.

C2—47 to 60 inches; brown (10YR 4/3) very gravelly loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; slightly effervescent; 40 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; mildly alkaline (pH 7.6).

Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 10 to 18 percent clay.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 2 or 3 moist or dry. It is 5 to 15 percent gravel-sized pumice and 5 to 15 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The Bw horizon has value of 3 or 4 moist and 4 to 6 dry, and it has chroma of 2 or 3 moist or dry. It is loam or sandy loam and is 5 to 15 percent gravel-sized pumice, 0 to 10 percent cobbles, and 5 to 15 percent pumice that is 0.5 to 2.0 millimeters in diameter. It is neutral or mildly alkaline.

The C horizon has value of 3 to 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or sandy loam and is 20 to 40 percent gravel-sized pumice and 10 to 20 percent pumice that is 0.5 to 2.0 millimeters in diameter. It is neutral or mildly alkaline.

Eaglespring Series

The Eaglespring series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 12 to 80 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Eaglespring channery loam, 30 to 55 percent slopes, in an area of rangeland; 2,000 feet west and 250 feet north of the southeast corner of sec. 25, T. 7 S., R. 12 E.

A—0 to 7 inches; black (10YR 2/1) channery loam, very dark gray (10YR 3/1) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine irregular pores and common medium irregular pores; 30 percent channers; neutral (pH 6.6); clear smooth boundary.

AB—7 to 13 inches; very dark brown (10YR 2/2) very channery loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to weak fine granular; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; 45 percent channers; neutral (pH 6.6); clear smooth boundary.

Bw1—13 to 31 inches; dark brown (10YR 3/3) extremely channery sandy loam, brown (10YR 4/3) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 70 percent channers; neutral (pH 6.8); clear smooth boundary.

Bw2—31 to 43 inches; dark yellowish brown (10YR 3/4) extremely channery loam, yellowish brown (10YR 5/4) dry; weak very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 75 percent channers; neutral (pH 6.8); clear wavy boundary.

R—43 inches; fractured sedimentary rock.

Depth to fractured bedrock is 40 to 60 inches. The mollic epipedon is 20 to 35 inches thick. The particle-size control section averages 18 to 25 percent clay.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 15 to 35 percent channers.

The AB horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 25 to 50 percent channers.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It is sandy loam or loam and is 60 to 75 percent channers.

Evick Series

The Evick series consists of shallow, somewhat excessively drained soils on south-facing canyonsides. These soils formed in residuum and colluvium derived dominantly from tuff with an influence of volcanic ash. Slopes are 30 to 65 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Evick gravelly loamy sand in an area of Evick-Rock outcrop complex, 30 to 65 percent slopes; 2,000 feet west and 2,100 feet south of the northeast corner of sec. 18, T. 10 S., R. 11 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A—0 to 3 inches; very dark brown (10YR 2/2) gravelly loamy sand, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; 25 percent gravel; neutral (pH 6.6); gradual smooth boundary.
Bw—3 to 11 inches; very dark brown (10YR 2/2) gravelly loamy sand, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; common very fine, fine, medium, and coarse tubular pores; 30 percent gravel; neutral (pH 6.6); abrupt smooth boundary.
R—11 inches; tuff.

Depth to tuff is 10 to 14 inches. The particle-size control section averages 5 to 10 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 30 percent gravel.

The Bw horizon has value of 2 or 3 moist and 6 or 7 dry, and it has chroma of 2 to 4 moist or dry. It is 25 to 35 percent gravel.

Fawnspring Series

The Fawnspring series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 2 to 30 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Fawnspring very gravelly silt loam in an area of Littlefawn-Fawnspring complex, 2 to 30 percent slopes, in an area of woodland; 400 feet east and 700 feet north of the southwest corner of sec. 19, T. 7 S., R. 13 E.

Oi—2 inches to 0; organic layer of needles and twigs.
A—0 to 3 inches; very dark gray (10YR 3/1) very gravelly silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure parting to moderate fine granular; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; 40 percent gravel; neutral (pH 7.0); clear smooth boundary.
Bw—3 to 8 inches; very dark grayish brown (10YR 3/2) very gravelly silty clay loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; many organic stains on faces of peds and lining pores; 40 percent gravel; slightly acid (pH 6.4); abrupt smooth boundary.
2Bt1—8 to 16 inches; dark brown (7.5YR 3/3) clay, brown (7.5YR 4/2) dry; strong very coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine, fine, and medium roots and few coarse roots; common very fine and fine tubular pores and few medium tubular pores; many prominent clay films on faces of peds and lining pores; 10 percent gravel; slightly acid (pH 6.2); clear smooth boundary.
2Bt2—16 to 26 inches; dark brown (7.5YR 3/3) clay, brown (7.5YR 4/2) dry; strong very coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few

very fine, fine, and medium roots; few very fine and fine tubular pores; continuous prominent clay films on faces of peds and lining pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

3C1—26 to 34 inches; weak red (10R 4/4) clay, red (2.5YR 4/6) dry; massive; extremely hard, extremely firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; slightly acid (pH 6.2); clear smooth boundary.

3C2—34 to 43 inches; weak red (10R 4/4) clay, red (2.5YR 4/6) dry; massive; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; slightly acid (pH 6.2); clear smooth boundary.

3Cr—43 inches; sedimentary rock.

Depth to sedimentary rock ranges from 40 to 60 inches. Depth to the discontinuity is 8 to 15 inches. The mollic epipedon is 20 to 35 inches thick. The particle-size control section averages 50 to 60 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 25 to 40 percent gravel and 0 to 10 percent cobbles.

The Bw horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 to 3 moist or dry. It is silt loam or silty clay loam and is 25 to 40 percent gravel and 0 to 10 percent cobbles.

The 2Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 1 to 3 moist or dry. It is clay or silty clay and is 0 to 10 percent gravel.

The 3C horizon has hue of 2.5YR or 10R, value of 4 or 5 moist and 4 to 6 dry, and chroma of 4 to 6 moist or dry. It is clay or silty clay and is 0 to 10 percent gravel.

Grenet Series

The Grenet series consists of moderately deep, somewhat excessively drained soils on mountains. These soils formed in residuum and colluvium derived from tuff and volcanic ash. Slopes are 0 to 65 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is 42 degrees F.

Typical pedon of Grenet very gravelly sandy loam, 12 to 30 percent slopes, in an area of woodland; 2,500 feet east and 2,000 feet north of the southwest corner of sec. 20, T. 6 S., R. 10 E.

Oi—1 inch to 0; organic layer of needles and twigs

A—0 to 4 inches; dark grayish brown (10YR 4/2) very gravelly sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 35 percent gravel; strongly acid (pH 5.4); clear wavy boundary.

AB—4 to 12 inches; grayish brown (10YR 5/2) very gravelly sandy loam, light gray (10YR 7/2) dry; moderate fine subangular blocky structure parting to weak medium granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 50 percent gravel; strongly acid (pH 5.4); clear smooth boundary.

Bw1—12 to 21 inches; grayish brown (10YR 5/2) extremely gravelly sandy loam, white (10YR 8/1) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 60 percent gravel and 5 percent cobbles; strongly acid (pH 5.2); clear smooth boundary.

Bw2—21 to 36 inches; light brownish gray (10YR 6/2) extremely gravelly loamy sand, white (10YR 8/1) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 70 percent gravel and 5 percent cobbles; strongly acid (pH 5.4); clear smooth boundary.

Cr—36 inches; tuff.

Depth to bedrock is 20 to 40 inches. The profile has hue of 7.5YR or 10YR. The particle-size control section averages 10 to 18 percent clay and is 35 to 80 percent rock fragments.

The A horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 1 or 2 moist or dry. It is 35 to 50 percent gravel.

The Bw horizon has value of 5 or 6 moist and 7 or 8 dry, and it has chroma of 1 or 2 moist or dry. It is sandy loam or loamy sand and is 50 to 70 percent gravel and 0 to 10 percent cobbles.

Happus Series

The Happus series consists of soils that are moderately deep to pumice and are somewhat excessively drained. These soils are on toe slopes of canyons. They formed in residuum and colluvium derived dominantly from volcanic ash and pumice. Slopes are 12 to 30 percent. The mean annual

precipitation is about 17 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Happus very gravelly sandy loam, 12 to 30 percent slopes, in an area of woodland; 1,000 feet east and 1,500 feet north of the southwest corner of sec. 7, T. 11 S., R. 11 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A—0 to 2 inches; dark brown (10YR 3/3) very gravelly sandy loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine, fine, and medium irregular pores; 45 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.2); clear smooth boundary.
AB—2 to 9 inches; dark brown (10YR 3/3) very gravelly sandy loam, light brownish gray (10YR 6/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 50 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.8); clear smooth boundary.
Bw1—9 to 17 inches; brown (10YR 4/3) extremely gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium and coarse tubular pores; 65 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.
Bw2—17 to 29 inches; brown (10YR 4/3) extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 80 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); abrupt wavy boundary.
C—29 to 60 inches; light gray (10YR 7/2) fragmental pumice, white (10YR 8/2) dry.

Depth to fragmental pumice is 20 to 40 inches. The particle-size control section averages 5 to 10 percent clay, 65 to 85 percent gravel-sized pumice, and 30 to 40 percent volcanic glass.

The A horizon has value of 2 or 3 moist and chroma of 2 or 3 moist or dry. It is 40 to 55 percent gravel-sized pumice and 5 to 15 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The Bw horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 2 to 4 moist or dry. It is sandy loam or loamy sand. It is 65 to 80 percent gravel-sized pumice and 10 to 20 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The C horizon has value of 7 or 8 moist or dry and chroma of 1 or 2 moist or dry.

Hehe Series

The Hehe series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived from andesite or basalt with an influence of volcanic ash. Slopes are 0 to 65 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Hehe very stony loam in an area of Hehe-Teewee complex, 0 to 12 percent slopes, in an area of woodland; 1,300 feet west and 900 feet south of the northeast corner of sec. 36, T. 8 S., R. 10 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A1—0 to 4 inches; dark brown (7.5YR 3/2) very stony loam, brown (7.5YR 5/3) dry; moderate fine and medium subangular blocky structure parting to weak fine granular; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 30 percent stones and 20 percent cobbles; moderately acid (pH 6.0); clear smooth boundary
A2—4 to 11 inches; dark brown (7.5YR 3/3) very stony loam, brown (7.5YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; common organic coatings on faces of peds; 30 percent stones and 20 percent cobbles; slightly acid (pH 6.2); clear smooth boundary.

Bt1—11 to 19 inches; dark brown (7.5YR 3/4) very bouldery loam, brown (7.5YR 5/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds; 25 percent boulders, 10 percent stones, and 15 percent cobbles; slightly acid (pH 6.2); gradual irregular boundary.
Bt2—19 to 38 inches; dark brown (7.5YR 3/4) very bouldery clay loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds; 25 percent boulders, 10 percent stones, and 15 percent cobbles; slightly acid (pH 6.4); abrupt wavy boundary.
Cr—38 inches; weathered andesite.

Depth to weathered bedrock is 20 to 40 inches. The profile has hue of 10YR or 7.5YR. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 20 to 35 percent clay and 35 to 70 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is very stony loam or very cobbly loam. The horizon is 5 to 35 percent stones, 10 to 30 percent cobbles, 0 to 10 percent gravel, and 0 to 5 percent boulders. It is 2 to 4 percent organic matter.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam. It is 10 to 25 percent boulders, 10 to 20 percent stones, 15 to 25 percent cobbles, and 0 to 5 percent gravel.

Howash Series

The Howash series consists of very deep, somewhat excessively drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite and volcanic ash. Slopes are 12 to 65 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Howash very gravelly sandy loam, 30 to 65 percent slopes, in an area of woodland; 2,600 feet west and 600 feet south of the northeast corner of sec. 13, T. 6 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.
A1—0 to 5 inches; very dark grayish brown (10YR 3/2) very gravelly sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores; 35 percent gravel and 10 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.
A2—5 to 14 inches; dark brown (10YR 3/3) very gravelly sandy loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 40 percent gravel and 10 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.
Bw1—14 to 22 inches; brown (10YR 4/3) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 35 percent gravel and 10 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.
Bw2—22 to 32 inches; brown (10YR 4/3) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 35 percent gravel and 15 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.
Bw3—32 to 48 inches; dark yellowish brown (10YR 4/4) very cobbly loam, light yellowish brown (10YR 6/4) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel and 20 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.
C—48 to 60 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; 50 percent cobbles, 15 percent gravel, and 20 percent soft andesite fragments; strongly acid (pH 5.4).

Depth to bedrock is more than 60 inches. The particle-size control section is 35 to 55 percent rock fragments, and it averages 10 to 18 percent clay. The umbric epipedon is 10 to 15 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is very gravelly sandy loam, very cobbly sandy loam, and

very stony sandy loam. The horizon is 10 to 45 percent gravel, 0 to 30 percent cobbles, and 0 to 30 percent stones.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or sandy loam. The horizon is 25 to 35 percent gravel, 10 to 30 percent cobbles, and 0 to 10 percent stones.

The C horizon is loam or sandy loam. It is 30 to 50 percent cobbles, 15 to 25 percent gravel, and 0 to 5 percent stones.

Jojo Series

The Jojo series consists of moderately deep, somewhat excessively drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from pyroclastic ashflow, andesite, and volcanic ash. Slopes are 0 to 70 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 36 degrees F.

Typical pedon of Jojo very stony sandy loam in an area of Pinhead-Jojo complex, 12 to 30 percent slopes, in an area of woodland; 2,000 feet north and 100 feet east of the southwest corner of sec. 25, T. 8 S., R. 8 E.

Oi—2 inches to 0; organic layer of needles and twigs.
A—0 to 7 inches; dark brown (7.5YR 3/3) very stony sandy loam, brown (7.5YR 4/3) dry; weak fine and medium subangular blocky structure parting to weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 35 percent stones, 10 percent cobbles, and 10 percent gravel; moderately acid (pH 5.8); clear wavy boundary.
2C1—7 to 18 inches; reddish brown (5YR 4/4) very gravelly sandy loam, brown (7.5YR 5/4) dry; massive; hard, firm, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 40 percent gravel, 10 percent cobbles, and 5 percent stones; moderately acid (pH 5.6); clear smooth boundary.
2C2—18 to 28 inches; reddish brown (5YR 4/4) extremely gravelly sandy loam, light brown (7.5YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 50 percent gravel and 20 percent cobbles; moderately acid (pH 5.6); clear wavy boundary.
2C3—28 to 32 inches; reddish brown (2.5YR 4/4) extremely gravelly loamy sand, light reddish brown (5YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 55 percent gravel and 15 percent cobbles; strongly acid (pH 5.5); abrupt wavy boundary.
2Cr1—32 to 36 inches; dusky red (2.5YR 3/2) pyroclastic ashflow.
3Cr2—36 to 60 inches; very dark brown (10YR 2/2) pyroclastic ashflow.

Depth to pyroclastic ashflow or andesite is 20 to 40 inches. The particle-size control section averages less than 15 percent clay, and it is 40 to 80 percent rock fragments.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist or dry, and chroma of 2 to 4 moist or dry. It is very stony sandy loam or very bouldery sandy loam. The horizon is 0 to 30 percent boulders, 10 to 40 percent stones, 5 to 10 percent cobbles, and 5 to 10 percent gravel.

The 2C horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 or 4 moist and 4 to 6 dry; and chroma of 3 or 4 moist or dry. It is sandy loam or loamy sand and is 35 to 55 percent gravel, 10 to 20 percent cobbles, and 0 to 5 percent stones.

The 2Cr horizon is pyroclastic ashflow or highly weathered andesite.

Jorn Series

The Jorn series consists of moderately deep, well drained soils on concave mountainsides. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash in the upper part. Slopes are 2 to 55 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Jorn cobbly silt loam in an area of Yawkola-Jorn-Rock outcrop complex, 2 to 30 percent slopes; 1,000 feet north and 500 feet east of the southwest corner of sec. 11, T. 6 S., R. 11 E.

A—0 to 5 inches; very dark brown (10YR 2/2) cobbly silt loam, grayish brown (10YR 5/2) dry; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 10 percent cobbles and 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.
Bt1—5 to 12 inches; very dark grayish brown (10YR 3/2) gravelly silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic;

many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse tubular pores; common distinct clay films on faces of peds and lining pores; 5 percent cobbles and 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt2—12 to 21 inches; dark brown (10YR 3/3) gravelly silty clay, grayish brown (10YR 5/3) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky and very plastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores and few medium and coarse tubular pores; many prominent clay films on faces of peds and lining pores; 20 percent gravel; neutral (pH 6.8); clear smooth boundary.

2Bt3—21 to 24 inches; dark yellowish brown (10YR 3/4) gravelly silty clay, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 15 percent hard gravel and 50 percent soft gravel-sized fragments; neutral (pH 6.6); gradual wavy boundary.

2Crt—24 inches; sedimentary rock with prominent clay films in fractures.

Depth to sedimentary rock is 20 to 40 inches. The mollic epipedon is 20 to 30 inches thick, and it includes the upper part of the Bt horizon. The profile has hue of 7.5YR or 10YR. The particle-size control section is 30 to 50 percent clay, but the weighted average is 35 to 45 percent.

The A horizon has value 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 10 to 20 percent cobbles and 5 to 10 percent gravel.

The Bt1 horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam and is 30 to 40 percent clay. It is 5 to 15 percent gravel and 5 to 10 percent cobbles.

The Bt2 horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay or clay and is 40 to 50 percent clay. It is 15 to 30 percent gravel and 0 to 5 percent cobbles.

The 2Bt3 horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is silty clay or clay and is 40 to 50 percent clay. It is 15 to 30 percent hard gravel and 30 to 50 percent soft gravel-sized fragments.

Kahneeta Series

The Kahneeta series consists of soils that are moderately deep to a duripan and are somewhat poorly drained. These soils are on outwash plains. They formed in alluvium and glacial outwash with an influence of loess in the upper part. Slopes are 0 to 3 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Kahneeta very cobbly silt loam in an area of Tenwalter-Kahneeta complex, 0 to 3 percent slopes, in an area of rangeland; 500 feet east and 2,000 feet north of the southwest corner of sec. 23, T. 8 S., R. 10 E.

A—0 to 4 inches; black (10YR 2/1) very cobbly silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores; 30 percent cobbles and 15 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

BA—4 to 9 inches; very dark brown (10YR 2/2) cobbly silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 15 percent cobbles and 15 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

Bt1—9 to 16 inches; dark brown (7.5YR 3/2) very cobbly silty clay loam, brown (7.5YR 4/2) dry; common fine distinct dark reddish brown (5YR 3/4) mottles; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 25 percent cobbles and 20 percent gravel; neutral (pH 6.6); abrupt wavy boundary.

2Bt2—16 to 25 inches; brown (7.5YR 4/4) extremely cobbly clay, brown (7.5YR 4/4) dry; common medium distinct dark reddish brown (5YR 3/4) mottles; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; many prominent clay films on faces of peds and lining pores; 40 percent cobbles and

25 percent gravel; neutral (pH 7.2); abrupt smooth boundary.
2Btqm—25 to 38 inches; indurated and strongly cemented duripan; extremely hard, very fine silica cap 1 millimeter thick; many prominent clay films in fractures; clay and silica pendants on bottom of fractures; neutral (pH 7.2); abrupt wavy boundary.
2Btq—38 to 60 inches; brown (7.5YR 4/4) extremely cobbly clay, brown (7.5YR 4/4) dry; massive; hard, firm, sticky and plastic; many prominent clay films on faces of rock fragments; 60 percent cobbles and 20 percent gravel; neutral (pH 7.0).

Depth to the duripan is 20 to 30 inches. Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section is 30 to 50 percent clay, but the weighted average is more than 35 percent.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 20 to 30 percent cobbles and 15 to 30 percent gravel.

The Bt horizon has hue of 7.5YR or 10YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam and is 30 to 40 percent clay. The horizon is 10 to 30 percent cobbles and 20 to 30 percent gravel. It has few faint to common medium distinct mottles. The horizon is slightly acid or neutral.

The 2Bt horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 to 6 dry, and it has chroma of 3 or 4 moist or dry. It has 40 to 50 percent clay, and is 20 to 40 percent cobbles, and 20 to 40 percent gravel. Mottles range from few fine distinct to common medium distinct. It is slightly acid or neutral.

The 2Btqm horizon is indurated and has 1- to 2-millimeter-thick laminar bands or is strongly cemented and indurated in the upper part. The horizon is 10 to 25 inches thick.

The 2Btq horizon is silty clay or clay and is 40 to 50 percent clay. It is 40 to 60 percent cobbles and 10 to 20 percent gravel.

Kaskela Series

The Kaskela series consists of deep, well drained soils on foothills. These soils formed in residuum and colluvium derived dominantly from sedimentary rock. Slopes are 0 to 30 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Kaskela clay in an area of Prill-Kaskela-Rock outcrop complex, 2 to 30 percent slopes, in an area of rangeland; 400 feet west and 1,700 feet north of the southeast corner of sec. 13, T. 7 S., R. 12 E.

A—0 to 4 inches; dark brown (7.5YR 3/2) clay, dark gray (5YR 4/1) dry; moderate very fine and fine subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine tubular pores; neutral (pH 7.0); clear smooth boundary.
Bt—4 to 10 inches; dark reddish brown (5YR 3/2) clay, dark gray (5YR 4/1) dry; strong fine and medium subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; continuous prominent clay films on faces of peds and lining pores; neutral (pH 6.8); clear smooth boundary.
Bss1—10 to 19 inches; dark reddish brown (5YR 3/2) clay, dark gray (5YR 4/1) dry; strong medium and coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; few very fine, fine, and medium tubular pores; common intersecting slickensides; neutral (pH 6.8); clear smooth boundary.
Bss2—19 to 31 inches; reddish brown (5YR 4/3) clay, dark reddish gray (5YR 4/2) dry; strong medium and coarse subangular blocky structure; very hard, very firm, sticky and plastic; few fine and medium roots; few fine and medium tubular pores; common intersecting slickensides; neutral (pH 6.6); clear smooth boundary.
Bk—31 to 42 inches; reddish brown (5YR 4/4) clay loam, reddish brown (5YR 4/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; strongly effervescent with disseminated lime; moderately alkaline (pH 8.0); clear smooth boundary.
Cr—42 inches; weathered sedimentary rock.

Depth to bedrock is 40 to 60 inches. The profile has hue of 2.5YR to 7.5YR. The particle-size control section averages 60 to 70 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 dry. It is clay or cobbly clay and is 0 to 10 percent gravel and 0 to 30 percent cobbles.

The Bt horizon has value of 3 or 4 moist or dry and chroma of 1 or 2 moist or dry. It is 0 to 10 percent gravel and 0 to 5 percent cobbles.

The Bss horizon has color similar to that of the Bt horizon. It has moderate or strong blocky structure and common or many intersecting slickensides. It is 0 to 10 percent gravel and 0 to 5 percent cobbles.

The Bk horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is silty clay loam or clay loam and is 30 to 40 percent clay. It is moderately alkaline or strongly alkaline.

Kishwalk Series

The Kishwalk series consists of moderately deep, well drained soils in canyons. These soils formed in colluvium derived dominantly from basalt and rhyolite. Slopes are 2 to 80 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Kishwalk very stony loam in an area of Waterbury-Kishwalk complex, 2 to 30 percent slopes, in an area of rangeland; 500 feet east and 1,200 feet south of the northwest corner of sec. 27, T. 8 S., R. 12 E.

A—0 to 5 inches; very dark brown (10YR 2/2) very stony loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 20 percent stones, 10 percent cobbles, and 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

BA—5 to 14 inches; very dark grayish brown (10YR 3/2) very stony loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; 20 percent stones, 15 percent cobbles, and 10 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt1—14 to 23 inches; very dark grayish brown (10YR 3/2) very stony clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 30 percent stones, 15 percent cobbles, and 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt2—23 to 31 inches; dark brown (10YR 3/3) extremely stony clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 40 percent stones, 15 percent cobbles, and 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt3—31 to 38 inches; brown (10YR 4/3) extremely stony clay, yellowish brown (10YR 5/4) dry; strong medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine tubular pores; many prominent clay films on faces of peds and lining pores; 50 percent stones, 20 percent cobbles, and 5 percent gravel; neutral (pH 7.0); abrupt wavy boundary.

R—38 inches; basalt.

Depth to bedrock is 20 to 40 inches. The mollic epipedon is 20 to 30 inches thick. The particle-size control section averages 35 to 55 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is very stony loam or very cobbly silt loam. The horizon is 5 to 30 percent stones, 10 to 35 percent cobbles, and 10 to 20 percent gravel.

The Bt1 and Bt2 horizons have value of 3 or 4 moist and 4 or 5 dry, and they have chroma of 2 to 4 moist or dry. These horizons are silty clay loam or clay loam. They are 15 to 40 percent stones, 10 to 30 percent cobbles, and 5 to 10 percent gravel.

The Bt3 horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is clay or silty clay. The horizon is 20 to 50 percent stones, 10 to 35 percent cobbles, and 5 to 10 percent gravel.

Kuckup Series

The Kuckup series consists of very deep, excessively drained soils on cinder cones. These soils formed in volcanic ash and cinders. Slopes are 15 to 40 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 35 degrees F.

Typical pedon of Kuckup gravelly sandy loam, 15 to 40 percent slopes, in an area of woodland; 2,500 feet west and 1,000 feet south of the northeast corner of sec. 20, T. 6 S., R. 9 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A—0 to 6 inches; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 5/3) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium

roots; many very fine, fine, and medium irregular pores; 25 percent gravel-sized cinders and 10 percent cinders that are 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.2); clear smooth boundary.

Bw1—6 to 13 inches; dark brown (7.5YR 3/3) gravelly sandy loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 25 percent gravel-sized cinders and 10 percent cinders that are 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.

Bw2—13 to 29 inches; dark reddish brown (5YR 3/4) gravelly sandy loam, reddish brown (5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; common fine and medium tubular pores; 30 percent gravel-sized cinders and 15 percent cinders that are 0.5 to 2.0 millimeters in diameter; neutral (pH 6.8); gradual wavy boundary.

2C—29 to 60 inches; reddish brown (5YR 4/3) cinders, light reddish brown (5YR 6/4) dry; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine vesicular pores; less than 10 percent of voids are filled; neutral (pH 6.8).

Depth to the 2C horizon is 20 to 30 inches. Depth to bedrock is more than 60 inches. The upper part of the particle-size control section averages 20 to 35 percent cinders, and the lower part averages 90 percent cinders or more.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is 20 to 30 percent gravel-sized cinders and 5 to 10 percent clay.

The Bw horizon has hue of 7.5YR or 5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is 25 to 35 percent gravel-sized cinders and 5 to 15 percent clay.

The 2C horizon has hue of 7.5YR, 5YR or 2.5YR; value of 3 or 4 moist and 4 to 6 dry; and chroma of 2 to 6 moist or dry. It is 80 to 100 percent gravel-sized cinders.

Kusu Series

The Kusu series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from tuff and volcanic ash. Slopes are 2 to 65 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Kusu very gravelly loam, 30 to 55 percent slopes, in an area of woodland; 1,000 feet east and 3,000 feet north of the southwest corner of sec. 30, T. 7 S., R. 13 E.

Oi—2 inches to 0; organic layer of needles and twigs

A—0 to 4 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 35 percent gravel; neutral (pH 6.6); clear smooth boundary.

AB—4 to 14 inches; dark yellowish brown (10YR 3/4) gravelly loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 25 percent gravel; neutral (pH 6.6); clear smooth boundary.

Bw1—14 to 22 inches; dark brown (10YR 4/3) very gravelly sandy loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; 35 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bw2—22 to 32 inches; dark brown (10YR 4/3) extremely gravelly loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; 65 percent gravel; slightly acid (pH 6.4); gradual smooth boundary.

Bw3—32 to 51 inches; brown (10YR 4/3) extremely gravelly loam, light pale brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 20 percent cobbles and 65 percent gravel; slightly acid (pH 6.2); clear wavy boundary.

R—51 inches; fractured tuff.

Depth to tuff is 40 to 60 inches. The particle-size control section averages 15 to 25 percent clay. It is neutral to moderately acid.

The A and AB horizons have value of 2 or 3 moist and 4 or 5 dry, and they have chroma of 2 to 4 moist or dry. They are very gravelly loam and very gravelly sandy loam and are 35 to 50 percent gravel.

The Bw horizon has value of 3 or 4 moist and 6 to 7 dry, and it has chroma of 3 or 4 moist or dry. It is loam or sandy loam and is 35 to 65 percent gravel and 0 to 20 percent cobbles.

Kutcher Series

The Kutcher series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash in the upper part. Slopes are 0 to 30 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Kutcher very cobbly sandy loam in an area of Mackatie-Kutcher complex, low precipitation, 0 to 12 percent slopes, in an area of woodland; 1,200 feet north and 500 feet west of the southeast corner of sec. 29, T. 5 S., R. 10 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A—0 to 5 inches; dark brown (7.5YR 3/3) very cobbly sandy loam, brown (7.5YR 5/3) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 25 percent cobbles, 10 percent gravel, and 5 percent stones; moderately acid (pH 5.8); clear smooth boundary.

AB—5 to 18 inches; dark brown (7.5YR 3/4) very cobbly sandy loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; 25 percent cobbles, 10 percent gravel, and 5 percent stones; moderately acid (pH 5.6); clear smooth boundary.

2Bt1—18 to 28 inches; dark brown (7.5YR 4/4) extremely cobbly loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; few faint clay films on faces of peds and lining pores; 60 percent cobbles and 5 percent stones; strongly acid (pH 5.4); clear smooth boundary.

2Bt2—28 to 38 inches; brown (7.5YR 4/4) extremely cobbly clay loam, light brown (7.5YR 6/4) dry; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 60 percent cobbles and 10 percent stones; moderately acid (pH 5.6); clear wavy boundary.

2Cr—38 inches; weathered andesite.

Depth to weathered andesite is 20 to 40 inches. The profile has hue of 7.5YR or 10YR. The particle-size control section is 35 to 85 percent rock fragments. The upper part is 10 to 15 percent clay, and the lower part is 25 to 35 percent clay. The profile is moderately acid or strongly acid.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 5 to 10 percent gravel, 25 to 35 percent cobbles, and 5 to 10 percent stones.

Texture of the AB horizon is similar to that of the A horizon. The AB horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 5 to 10 percent gravel, 25 to 35 percent cobbles, and 5 to 10 percent stones.

The 2Bt horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam and is 60 to 70 percent cobbles, 5 to 10 percent stones, and 0 to 5 percent gravel.

Lavey Series

The Lavey series consists of moderately deep, well drained soils on low foothills. These soils formed in loess over colluvium derived from sedimentary rock or tuff. Slopes are 2 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Lavey gravelly silt loam, 2 to 15 percent slopes, in an area of rangeland; 100 feet east and 300 feet north of the southwest corner of sec. 25, T. 9 S. R. 12 E.

A—0 to 5 inches; dark brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine irregular pores; 20 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt1—5 to 12 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, and medium roots; common very fine and fine tubular pores; many faint clay films on faces of peds and lining pores; 5 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

Bt2—12 to 21 inches; dark grayish brown (10YR 4/2) clay, pale brown (10YR 6/3) dry; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine, fine, and medium roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 10 percent gravel; mildly alkaline (pH 7.0); clear wavy boundary.

Btk—21 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common faint clay films on faces of peds and lining pores; slightly effervescent with segregated lime in soft masses 1 to 2 millimeters in diameter; moderately alkaline (pH 8.0); abrupt wavy boundary.

2Crkq—25 to 28 inches; paralithic tuff with coatings of silica and calcium carbonate; strongly effervescent with disseminated lime.

2R—28 inches; welded tuff of the Deschutes Formation.

Depth to a Crkq horizon over a lithic contact is 20 to 40 inches. The mollic epipedon is 10 to 15 inches thick. Depth to secondary carbonates is 20 to 36 inches. The particle-size control section averages 35 to 45 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is gravelly silt loam or very cobbly silty clay loam and is 15 to 30 percent gravel and 0 to 40 percent cobbles.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay loam or clay and is 5 to 15 percent gravel and 0 to 5 percent cobbles. It is neutral or mildly alkaline.

The Btk horizon has hue of 10YR to 5YR, value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is silty clay loam or clay and is 0 to 10 percent gravel.

The 2Crkq horizon is paralithic tuff or waterlain sediment of the Deschutes Formation. It is strongly effervescent or violently effervescent.

Lickskillet Series

The Lickskillet series consists of shallow, well drained soils in canyons. These soils formed in colluvium derived dominantly from basalt. Slopes are 15 to 70 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Lickskillet extremely stony loam, 40 to 70 percent slopes; 1,400 feet east and 1,000 south of the northwest corner of sec. 21, T. 6 S., R. 13 E.

A—0 to 4 inches; very dark brown (10YR 2/2) extremely stony loam, brown (10YR 4/3) dry; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; 35 percent stones, 15 percent cobbles, and 20 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

BA—4 to 9 inches; very dark brown (10YR 2/2) extremely stony loam, brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium tubular pores; 30 percent stones, 15 percent cobbles, and 15 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bw1—9 to 15 inches; dark brown (7.5YR 3/2) extremely stony clay loam, brown (10YR 4/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; 45 percent stones, 10 percent cobbles, and 25 percent gravel; neutral (pH 6.6); gradual wavy boundary.

Bw2—15 to 18 inches; brown (7.5YR 4/3) extremely stony clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; few faint clay films on rock fragments; 45 percent stones, 10 percent cobbles, and 25 percent gravel; neutral (pH 6.6); abrupt smooth boundary

2R—18 inches; basalt.

Depth to bedrock is 12 to 20 inches. The particle-size control section averages 20 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 35 percent stones, 15 to 30 percent cobbles, and 15 to 25 percent gravel.

The Bw horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is 30 to 50 percent stones, 10 to 30 percent gravel, and 10 to 20 percent cobbles.

Littlefawn Series

The Littlefawn series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 2 to 55 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Littlefawn gravelly loam in an area of Littlefawn-Fawnspring complex, 2 to 30 percent slopes, in an area of woodland; 1,000 feet east and 2,000 feet north of the southwest corner of sec. 16, T. 7 S., R. 13 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A1—0 to 3 inches; dark brown (10YR 3/3) gravelly loam, light brownish gray (10YR 6/2) dry; weak fine and medium granular structure parting to weak thin platy; soft, very friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 15 percent gravel; neutral (pH 6.8); clear smooth boundary.

A2—3 to 10 inches; dark brown (10YR 3/3) gravelly loam, light brownish gray (10YR 6/2) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 30 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bw—10 to 17 inches; brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; 15 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

2Bt1—17 to 22 inches; brown (10YR 4/3) gravelly silty clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 30 percent gravel; slightly acid (pH 6.2); clear wavy boundary.

3Bt2—22 to 32 inches; dark reddish brown (5YR 3/3) gravelly clay, brown (7.5YR 4/2) dry; massive; extremely hard, extremely firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; continuous prominent clay films on faces of peds and lining pores; 20 percent gravel; moderately acid (pH 6.0); abrupt wavy boundary.

3Cr—32 inches; sedimentary rock.

Depth to sedimentary rock is 20 to 40 inches. Depth to the discontinuity is 14 to 20 inches. The particle-size control section is 35 to 50 percent clay and 20 to 35 percent rock fragments.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 5 or 6 dry, and chroma of 2 or 3 moist or dry. It is 15 to 30 percent gravel.

The Bw horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 2 or 3 moist or dry. It is 15 to 35 percent gravel.

The 2Bt horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam and is 35 to 40 percent clay. It is 20 to 35 percent gravel and 0 to 5 percent cobbles.

The 3Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is clay or silty clay and is 40 to 50 percent clay. It is 20 to 35 percent gravel and 0 to 5 percent cobbles.

Logsprings Series

The Logsprings series consists of very deep, moderately well drained soils on benches of foothills. These soils formed in alluvium and colluvium over residuum derived dominantly from sedimentary rock with an influence of volcanic ash in the upper part. Slopes are 0 to 8 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Logsprings loam, 0 to 8 percent slopes, in an area of woodland; 2,300 feet east and 2,500 feet north of the southwest corner of sec. 16, T. 6 S., R. 11 E.

A—0 to 10 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; moderate medium platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine

and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; few fine faint organic stains on faces of peds and lining pores; 5 percent gravel; neutral (pH 7.0); gradual smooth boundary.

Bt1—10 to 21 inches; brown (7.5YR 4/2) loam, pinkish gray (7.5YR 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium and coarse tubular pores; common distinct clay films on faces of peds and lining pores; few fine faint organic stains on faces of peds and lining pores; 10 percent gravel; slightly acid (pH 6.4); abrupt smooth boundary.

2Bt2—21 to 30 inches; dark brown (7.5YR 3/3) clay, light brown (7.5YR 6/3) dry; strong coarse prismatic structure; very hard, very firm, very sticky and very plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; continuous prominent clay films on faces of peds and lining pores; common very fine and fine manganese stains; many distinct organic stains on faces of peds and lining pores; slightly acid (pH 6.2); clear smooth boundary.

3Bt3—30 to 36 inches; dark brown (7.5YR 4/3) extremely gravelly sandy clay loam, light brown (7.5YR 6/3) dry; moderate medium subangular blocky structure; very hard, very firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; many distinct clay films on faces of peds and lining pores; many distinct organic stains on faces of peds and lining pores; 65 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

4BCt—36 to 64 inches; dark brown (7.5YR 4/2) loam, pinkish gray (7.5YR 6/2) dry; moderate medium and fine subangular blocky structure; hard, firm, nonsticky and nonplastic; common fine and coarse roots along faces of peds; common very fine and fine tubular pores; many faint clay films on faces of peds; many organic stains on faces of peds; 5 percent gravel; slightly acid (pH 6.2).

Depth to sedimentary rock is more than 60 inches. Depth to the discontinuity is 20 to 30 inches. The upper part of the particle-size control section is 20 to 27 percent clay, and the lower part is 40 to 50 percent clay. The profile has hue of 7.5YR or 10YR.

The A horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 1 or 2 moist or dry. It is 0 to 5 percent gravel.

The Bt1 horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 27 percent clay and is 0 to 10 percent gravel.

The 2Bt2 horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is clay or silty clay and is 40 to 50 percent clay.

The 3Bt3 horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is sandy clay loam or clay loam and is 30 to 40 percent clay. It is 60 to 70 percent gravel.

The 4BCt horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 2 or 3 moist or dry. It is loam or silt loam and is 10 to 20 percent clay. It is 0 to 10 percent gravel.

Mackatie Series

The Mackatie series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash in the upper part. Slopes are 0 to 30 percent. The mean annual precipitation is about 65 inches, and the mean annual air temperature is about 40 degrees F.

Typical pedon of Mackatie sandy loam in an area of Mackatie-Kutcher complex, low precipitation, 0 to 12 percent slopes, in an area of woodland; 3,000 feet west and 2,000 feet north of the southeast corner of sec. 20, T. 5 S., R. 10 E.

Oi—3 inches to 0; organic layer of needles and twigs.

A—0 to 6 inches; dark brown (7.5YR 3/2) sandy loam, brown (7.5YR 4/3) dry; weak medium subangular blocky structure parting to weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 5 percent gravel and 5 percent cobbles; strongly acid (pH 5.4); clear smooth boundary.

AB—6 to 18 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 5 percent gravel and 5 percent cobbles; strongly acid (pH 5.3); clear smooth boundary.

2Bt1—18 to 28 inches; dark brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium tubular pores; few faint clay films on faces of peds and lining pores; 10 percent gravel; strongly acid (pH 5.4); clear smooth boundary.
2Bt2—28 to 41 inches; brown (10YR 4/3) clay loam, light yellowish brown (10YR 6/4) dry; moderate coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; common distinct clay films on faces of peds and lining pores; 10 percent gravel; moderately acid (pH 5.9); abrupt smooth boundary.
3C—41 to 51 inches; brown (10YR 4/3) extremely cobbly clay loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; 50 percent cobbles and 20 percent gravel; strongly acid (pH 5.2); clear wavy boundary.
3Cr—51 inches; weathered andesite.

Depth to weathered andesite is 40 to 60 inches. The profile has hue of 10YR or 7.5YR. The upper part of the particle-size control section averages 10 to 15 percent clay, and the lower, contrasting part averages 25 to 35 percent clay. The profile is moderately acid or strongly acid.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles.

Texture of the AB horizon is similar to that of the A horizon. The AB horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles.

The 2Bt horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam and is 10 to 20 percent gravel and 0 to 10 percent cobbles.

The 3C horizon, where present, has color similar to that of the 2Bt2 horizon. The 3C horizon is 45 to 60 percent cobbles and 10 to 20 percent gravel.

Madras Series

The Madras series consists of moderately deep, well drained soils on low foothills. These soils formed in loess over colluvium derived from sedimentary rock or tuff. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Madras loam, 0 to 8 percent slopes, in an area of rangeland; 2,000 feet north and 1,000 feet east of the southwest corner of sec. 13, T. 12 S., R. 9 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate very thin platy structure; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; few very fine and fine irregular pores; neutral (pH 6.8); clear wavy boundary.
A2—4 to 10 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; few very fine and fine tubular pores; neutral (pH 6.8); clear wavy boundary.
Bt1—10 to 16 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine, fine, and medium roots; common very fine tubular pores; few faint clay films on faces of peds and lining pores; neutral (pH 7.2); gradual wavy boundary.
Bt2—16 to 25 inches; dark yellowish brown (10YR 3/4) clay loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; common distinct clay films on faces of peds and lining pores; 10 percent gravel and 5 percent pumice fragments 1 to 5 millimeters in diameter; mildly alkaline (pH 7.4); clear wavy boundary.
Bt3—25 to 33 inches; dark yellowish brown (10YR 3/4) clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; common distinct clay films on faces of peds and lining pores; 2 percent cobbles and 10 percent pumice fragments 1 to 5 millimeters in diameter; mildly alkaline (pH 7.6); abrupt smooth boundary.
2Crkq—33 to 35 inches; paralithic tuff with coatings of silica and calcium carbonate; strongly effervescent with disseminated lime.
2R—35 inches; welded tuff of the Deschutes Formation.

Depth to hard bedrock is 22 to 40 inches. The mollic epipedon is 10 to 15 inches thick. The particle-size control section averages 27 to 35 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel and 10 to 30 percent volcanic glass.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 10 percent gravel and 0 to 5 percent cobbles.

The 2Crkq horizon is paralithic tuff or waterlain sediment of the Deschutes Formation. It is strongly effervescent or violently effervescent.

Mariel Series

The Mariel series consists of very deep, very poorly drained organic soils in mountain bogs. These soils formed in organic material. Slopes are 0 to 3 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 35 degrees F.

Typical pedon of Mariel mucky peat, 0 to 3 percent slopes, 3,000 feet west and 500 feet north of the southeast corner of sec. 8, T. 9 S., R. 9 E.

Oe1—0 to 7 inches; black (10YR 2/1) hemic material, rubbed and pressed; about 100 percent unrubbed fibers, 40 percent rubbed; many very fine, fine, and medium roots; strongly acid (pH 5.4); gradual smooth boundary.

Oe2—7 to 14 inches; very dark brown (10YR 2/2) hemic material, rubbed and pressed; about 90 percent unrubbed fibers, 30 percent rubbed; many very fine and fine roots; strongly acid (pH 5.4); clear wavy boundary.

Oe3—14 to 34 inches; very dark gray (10YR 3/1) hemic material, rubbed and pressed; about 60 percent unrubbed fibers, 25 percent rubbed; many very fine roots; strongly acid (pH 5.4); clear smooth boundary.

Oa—34 to 60 inches; very dark brown (10YR 2/2) sapric material, rubbed and pressed, about 40 percent unrubbed fibers, 10 percent rubbed; many very fine roots; strongly acid (pH 5.2);

Depth to bedrock is more than 60 inches. Depth to sapric material is 28 to 35 inches.

The surface tier has chroma of 1 or 2 moist. It is 80 to 100 percent unrubbed fibric material and 30 to 40 percent rubbed. The subsurface tier has value 2 or 3 moist and chroma of 1 or 2 moist. More than half of this tier is 50 to 60 percent unrubbed hemic material and 25 to 35 percent rubbed hemic material.

The bottom tier has value 2 to 4 moist and chroma of 1 or 2 moist. It is 30 to 50 percent unrubbed sapric material and 5 to 15 percent rubbed sapric material.

Maupin Series

The Maupin series consists of soils that are moderately deep to a duripan and are well drained. These soils are on mesas. They formed in loess. Slopes are 0 to 8 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Maupin silt loam in an area of Bakeoven-Maupin complex, 0 to 8 percent slopes, in an area of rangeland; 2,500 feet north and 1,500 feet east of the southwest corner of sec. 2, T. 9 S., R. 13 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak moderate granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 3 percent gravel; neutral (pH 6.8); clear smooth boundary.

AB—4 to 7 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 3 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bw1—7 to 14 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 5 percent gravel; neutral (pH 7.3); clear smooth boundary.

Bw2—14 to 20 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; strong medium subangular blocky structure; hard, firm, slightly sticky and plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 5 percent gravel; mildly alkaline (pH 7.6); clear smooth boundary.

Bk—20 to 25 inches; brown (10YR 4/3) gravelly loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; strongly effervescent with

segregated lime in blotches; 25 percent gravel; moderately alkaline (pH 7.9); abrupt smooth boundary.

Bkqm—25 to 31 inches; indurated duripan; platy structure; extremely hard, very firm; continuous silica laminar cap 1 millimeter thick; violently effervescent; abrupt smooth boundary.

2R—31 inches; basalt.

Depth to bedrock is 25 to 40 inches. Depth to the duripan is 20 to 30 inches. The mollic epipedon is 10 to 15 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry. It is silt loam or loam and is 0 to 10 percent gravel.

The Bk horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam or loam and is 20 to 30 percent gravel.

The Bkqm horizon is indurated throughout. It is 5 to 10 inches thick.

Milldam Series

The Milldam series consists of soils that are moderately deep to a duripan and are well drained. These soils are on outwash plains. They formed in glacial outwash with an influence of loess in the upper part. Slopes are 0 to 3 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Milldam silt loam in an area of Milldam-Tenwalter complex, 0 to 3 percent slopes, in an area of rangeland; 2,200 feet west and 1,300 feet north of the southeast corner of sec. 18, T. 8 S., R. 11 E.

A1—0 to 2 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 2 percent gravel; slightly acid (pH 6.2); gradual smooth boundary.

A2—2 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 2 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bt1—10 to 34 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; many distinct clay films on faces of peds and lining pores; 2 percent gravel; neutral (pH 6.8); clear wavy boundary.

2Bt2—34 to 37 inches; brown (10YR 4/3) cobbly clay, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; continuous prominent clay films on faces of peds and lining pores; 15 percent cobbles and 5 percent gravel; neutral (pH 6.8); abrupt wavy boundary.

2Btqm—37 to 51 inches; duripan; indurated and strongly cemented; extremely hard and very firm; silica cap 1 millimeter thick; many prominent clay films in fractures; pendants of clay and silica on bottom of fractures; neutral (pH 7.2); abrupt wavy boundary.

2Btq—51 to 60 inches; brown (7.5YR 4/4) extremely cobbly clay, brown (7.5YR 4/4) dry; massive; hard, firm and brittle, sticky and plastic; many prominent clay films on faces of rock fragments; 60 percent cobbles and 20 percent gravel; neutral (pH 7.0).

Depth to the duripan is 30 to 40 inches. Depth to bedrock is more than 60 inches. The mollic epipedon is 20 to 35 inches thick. The particle-size control section is 27 to 40 percent clay, but the weighted average is less than 35 percent.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 5 percent gravel.

The Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is silt loam, silty clay loam, or clay loam and is 25 to 30 percent clay. It is 0 to 10 percent gravel. It is slightly acid or neutral.

The 2Bt horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 to 6 dry, and chroma of 3 or 4 moist or dry. It is clay or silty clay loam and is 35 to 45 percent clay. The horizon is 10 to 20 percent cobbles and 0 to 10 percent gravel. It is slightly acid or neutral.

The 2Btqm horizon is indurated and has a 1- to 2-millimeter-thick laminar cap or is strongly cemented in the upper few inches. It is 10 to 25 inches thick.

The 2Btq horizon is clay or silty clay and is 40 to 50 percent clay. It is 40 to 60 percent cobbles and 10 to 20 percent gravel.

Millerflat Series

The Millerflat series consists of very deep, moderately well drained soils on stream terraces. These soils formed in alluvium derived from mixed sources with an influence of volcanic ash. Slopes are 0 to 3 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 42 degrees F.

Typical pedon of Millerflat loam, 0 to 3 percent slopes, in an area of woodland; 1,500 feet west and 2,000 feet north of the southeast corner of sec. 14, T. 6 S., R. 10 E.

Oi—2 inches to 0; organic layer of needles and twigs.
A1—0 to 6 inches; very dark brown (7.5YR 2/2) loam, dark brown (7.5YR 4/2) dry; weak medium platy structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 10 percent gravel; moderately acid (pH 5.8); clear smooth boundary.
A2—6 to 14 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 5 percent gravel; moderately acid (pH 5.8); clear smooth boundary.
A3—14 to 22 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 5 percent gravel; moderately acid (pH 5.6); clear smooth boundary.
Bw1—22 to 29 inches; dark brown (7.5YR 4/3) loam, light brown (7.5YR 6/3) dry; few fine distinct strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; ommon very fine and fine tubular pores and few medium tubular pores; moderately acid (pH 5.6); clear smooth boundary.
Bw2—29 to 35 inches; brown (7.5YR 4/3) loam, light brown (7.5YR 6/3) dry; common fine distinct dark brown (7.5YR 3/2) and strong brown (7.5YR 4/6) mottles; moderate medium and coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 5 percent gravel; moderately acid (pH 5.6); clear smooth boundary.
2Bt1—35 to 48 inches; brown (7.5YR 4/4) extremely gravelly sandy clay loam, light brown (7.5YR 6/3) dry; many fine distinct dark brown (7.5YR 3/2) and strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine tubular pores; few faint thin clay films on rock fragments and faces of peds; 55 percent gravel and 10 percent cobbles; moderately acid (pH 5.6); clear wavy boundary
2Bt2—48 to 60 inches; brown (7.5YR 4/4) extremely gravelly sandy clay loam, light brown (7.5YR 6/3) dry; many fine distinct dark brown (7.5YR 4/2) mottles; weak medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine tubular pores; many distinct clay films on rock fragments and faces of peds; 60 percent gravel and 15 percent cobbles; moderately acid (pH 5.6).

Depth to stratified gravelly and sandy alluvium is more than 60 inches. The particle-size control section is 45 to 80 percent rock fragments and 25 to 35 percent clay. The mollic epipedon is 20 to 30 inches thick. Depth to mottles that have chroma of 2 or less is 20 to 30 inches. Depth to the 2Bt horizon is 30 to 40 inches.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is loam or silt loam and is 15 to 20 percent clay. It is 0 to 10 percent gravel.

The 2Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5 moist and 5 or 6 dry, and chroma of 2 to 4 moist or dry. It is sandy clay loam or clay loam and is 45 to 80 percent gravel and 5 to 20 percent cobbles.

Mowako Series

The Mowako series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 30 to 80 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Mowako extremely channery loam, 30 to 55 percent slopes, in an area of woodland; 1,000 feet east and 1,500 feet north of the southwest corner of sec. 23, T. 7 S., R. 13 E.

Oi—1 inch to 0; organic layer of needles and twigs
A—0 to 3 inches; very dark brown (10YR 2/2) extremely channery loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 65 percent channers; slightly acid (pH 6.2); clear smooth boundary.
AB—3 to 9 inches; dark brown (10YR 3/3) extremely channery loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 65 percent channers; slightly acid (pH 6.4); clear smooth boundary.
Bw1—9 to 16 inches; dark brown (10YR 3/3) extremely channery loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; organic stains on faces of peds; 65 percent channers; neutral (pH 6.6); clear smooth boundary.
Bw2—16 to 23 inches; brown (10YR 4/3) extremely channery loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; organic stains on faces of peds; 70 percent channers; neutral (pH 6.8); clear smooth boundary.
Bw3—23 to 27 inches; brown (10YR 4/3) extremely channery loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; organic stains on faces of peds; 70 percent channers; neutral (pH 6.8); clear smooth boundary.
R—27 inches; fractured sedimentary rock.

Depth to sedimentary rock is 20 to 40 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 18 to 30 percent clay and more than 65 percent rock fragments.

The A and AB horizons have value of 2 or 3 moist and 4 or 5 dry, and they have chroma of 2 or 3 moist or dry. They are 60 to 70 percent channers.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam and is 18 to 30 percent clay. It is 65 to 80 percent channers.

Mutton Series

The Mutton series consists of very deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from tuff with an influence of volcanic ash. Slopes are 12 to 80 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Mutton gravelly loam in an area of Mutton-Littlefawn complex, 30 to 55 percent slopes, in an area of woodland; 500 feet east and 400 feet north of the southwest corner of sec. 11, T. 7 S., R. 13 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A—0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine irregular pores and common medium irregular pores; 20 percent gravel; neutral (pH 6.8); clear smooth boundary.
BA—8 to 17 inches; dark brown (10YR 3/3) gravelly loam, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 30 percent gravel; neutral (pH 6.6); clear smooth boundary.
Bw1—17 to 28 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; organic stains on faces of peds and lining pores; 35 percent gravel; slightly acid (pH 6.4); clear smooth boundary.
Bw2—28 to 36 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; organic stains on faces of peds and lining pores; 45 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bw3—36 to 44 inches; dark brown (10YR 3/3) extremely gravelly loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; organic stains on faces of peds and lining pores; 65 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

2Bt—44 to 60 inches; brown (10YR 4/3) extremely stony silty clay loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common distinct clay film on faces of peds and lining pores; 40 percent stones, 20 percent cobbles, and 10 percent gravel; slightly acid (pH 6.2).

Depth to bedrock is more than 60 inches. The particle-size control section is 15 to 25 percent clay. The profile has hue of 10YR or 7.5YR.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 35 percent gravel.

The BA horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 30 to 40 percent gravel.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 35 to 65 percent gravel.

The 2Bt horizon has value of 4 to 6 moist or dry. It is silty clay loam or clay loam. The horizon is 10 to 40 percent stones, 15 to 20 percent cobbles, and 10 to 20 percent gravel.

Olallie Series

The Olallie series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium derived from mixed sources. Slopes are 0 to 3 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Olallie clay loam, 0 to 3 percent slopes, in a pasture; 1,500 feet east and 2,200 feet south of the northwest corner of sec. 5, T. 8 S., R. 11 E.

Ap1—0 to 3 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; many fine distinct brown (7.5YR 4/4) mottles; weak medium platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; 5 percent gravel; slightly acid (pH 6.4); gradual smooth boundary.

Ap2—3 to 13 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) dry; many fine distinct brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 5 percent gravel; slightly acid (pH 6.4); clear wavy boundary.

Bw—13 to 23 inches; very dark brown (10YR 2/2) very gravelly clay loam, dark grayish brown (10YR 4/2) dry; many fine distinct reddish brown (5YR 4/4) mottles; black (10YR 2/1) organic stains; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine tubular pores; 30 percent gravel and 5 percent cobbles; neutral (pH 6.6); clear smooth boundary.

2C1—23 to 33 inches; dark brown (10YR 3/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; many fine distinct reddish brown (5YR 4/4) mottles; massive; hard, friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine tubular pores; 60 percent gravel and 10 percent cobbles; neutral (pH 6.8); clear smooth boundary.

2C2—33 to 44 inches; dark brown (10YR 4/3) extremely gravelly fine sandy loam, brown (10YR 5/3) dry; many fine distinct reddish brown (5YR 4/4) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few fine roots; common fine tubular pores; 50 percent gravel and 20 percent cobbles; neutral (pH 7.0); clear smooth boundary.

3C—44 to 60 inches; brown (10YR 5/3) extremely gravelly loamy sand, pale brown (10YR 6/3) dry; many distinct reddish brown (5YR 4/4) mottles; massive; hard, friable, nonsticky and nonplastic; 70 percent gravel and 15 percent cobbles; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. The mollic epipedon is 25 to 40 inches thick. The particle-size control section is 20 to 35 percent clay, and it averages 35 to 55 percent rock fragments. The profile has common fine distinct mottles to many fine prominent mottles throughout.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 27 to 35 percent clay and 0 to 10 percent gravel.

The Bw horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 moist or dry. It is clay loam or silty clay loam and is 27 to 35 percent clay. It is 25 to 40 percent gravel and 5 to 10 percent cobbles.

The 2C horizon has value of 3 or 4 moist and 4 to 6 dry, and it has chroma of 3 or 4 moist or dry. It is 15 to 25 percent clay. It is 40 to 60 percent gravel and 5 to 20 percent cobbles.

The 3C horizon has value of 4 or 5 moist and 4 to 6 dry, and it has chroma of 3 or 4 moist or dry. It is sandy loam or loamy sand and is 5 to 10 percent clay. It is 60 to 70 percent gravel and 5 to 15 percent cobbles.

Oldsferry Series

The Oldsferry series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock. Slopes are 30 to 80 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Oldsferry extremely channery loam in an area of Oldsferry-Venator complex, 30 to 55 percent slopes, in an area of rangeland; 1,000 feet west and 1,500 feet north of the southeast corner of sec. 36, T. 7 S., R. 12 E.

A—0 to 5 inches; very dark brown (10YR 2/2) extremely channery loam, grayish brown (10YR 5/2) dry; weak fine subangular structure parting to weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 65 percent channers; neutral (pH 6.8); clear smooth boundary.

A2—5 to 12 inches; very dark grayish brown (10YR 3/2) extremely channery loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 65 percent channers; neutral (pH 6.6); clear smooth boundary.

Bw1—12 to 21 inches; dark brown (10YR 3/3) extremely channery loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 70 percent channers; neutral (pH 6.6); clear wavy boundary.

Bw2—21 to 35 inches; brown (10YR 4/3) extremely channery loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 70 percent channers; slightly acid (pH 6.4); gradual wavy boundary.

R—35 inches; fractured sedimentary rock

Depth to bedrock is 20 to 40 inches. The particle-size control section averages 15 to 25 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 60 to 70 percent channers.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 50 to 70 percent channers.

Peahke Series

The Peahke series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 2 to 55 percent. The mean annual precipitation is about 23 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Peahke extremely channery loam, 2 to 30 percent slope, in an area of woodland; 500 feet west and 2,000 feet south of the northeast corner of sec. 22, T. 7 S., R. 13 E.

Oi—1 inch to 0; organic layer of needles and twigs

A—0 to 4 inches; very dark gray (10YR 3/1) extremely channery loam, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 65 percent channers; slightly acid (pH 6.2); clear smooth boundary.

Bw1—4 to 13 inches; dark brown (10YR 3/3) extremely channery loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure parting to moderate fine granular structure; slightly hard; friable; nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine, fine, and medium tubular pores; 65 percent channers; slightly acid (pH 6.4); clear smooth boundary.

Bw2—13 to 32 inches; dark grayish brown (10YR 4/2) extremely channery loam, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and common fine and medium roots; many very fine tubular pores and common fine and medium tubular pores; 75 percent channers; neutral (pH 6.6); gradual wavy boundary.

R—32 inches; fractured sedimentary rock.

Depth to sedimentary rock is 20 to 40 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 18 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 to 3 moist or dry. It is 60 to 70 percent channers.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is loam or clay loam and is 60 to 75 percent channers.

Pelton Series

The Pelton series consists of very deep, well drained soils on flood plains. These soils formed in alluvium derived from mixed sources. Slopes are 0 to 3 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Pelton sandy loam in an area of Pelton-Willowdale complex, 0 to 3 percent slopes, in an area of rangeland; 2,000 feet east and 2,200 feet north of the southwest corner of sec. 21, T. 8 S., R. 14 E.

A1—0 to 4 inches; very dark gray (10YR 3/1) sandy loam, grayish brown (10YR 5/2) dry; moderate thin and medium platy structure parting to moderate fine and medium granular; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 5 percent gravel; neutral (pH 6.9); gradual smooth boundary.

A2—4 to 10 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 15 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

2Bw—10 to 18 inches; dark brown (7.5YR 3/2) very gravelly sandy loam, brown (7.5YR 5/3) dry; moderate fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 45 percent gravel and 5 percent cobbles; mildly alkaline (pH 7.4); abrupt smooth boundary.

2C1—18 to 37 inches; dark brown (7.5YR 4/2) extremely cobbly sandy clay loam, brown (7.5YR 5/3) dry; massive; hard, firm, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; 50 percent cobbles and 30 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

2C2—37 to 47 inches; dark brown (7.5YR 4/2) extremely cobbly sandy clay loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; 40 percent cobbles and 30 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

2C3—47 to 60 inches; dark brown (7.5YR 4/3) extremely cobbly loamy sand, brown (7.5YR 5/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; 40 percent cobbles and 30 percent gravel; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to the discontinuity is 10 to 20 inches. The particle-size control section averages 18 to 25 percent clay, more than 50 percent sand, and 40 to 85 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 5 to 10 percent gravel and 0 to 5 percent cobbles.

The A2 horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is very gravelly sandy loam or sandy loam and is 10 to 25 percent gravel and 0 to 10 percent cobbles.

The 2Bw horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 40 to 50 percent gravel and 5 to 15 percent cobbles.

The 2C horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. The upper part is sandy clay loam, and the lower part is sandy loam or loamy sand. The horizon is 40 to 50 percent cobbles and 25 to 40 percent gravel.

Pinhead Series

The Pinhead series consists of very deep, somewhat excessively drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite and volcanic ash. Slopes are 0 to 65 percent. The mean annual precipitation is about 90 inches, and the mean annual air temperature is about 36 degrees F.

Typical pedon of Pinhead very gravelly sandy loam, warm, 0 to 12 percent slopes, in an area of woodland; 1,500 feet south and 2,500 feet east of the northwest corner of sec. 14, T. 6 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A—0 to 8 inches; dark brown (7.5YR 3/3) very gravelly sandy loam, brown (10YR 4/3) dry; weak fine

granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 40 percent gravel and 5 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.

AB—8 to 18 inches; dark brown (7.5YR 3/4) very gravelly sandy loam, dark yellowish brown (10YR 4/4) dry; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 40 percent gravel and 10 percent cobbles; strongly acid (pH 5.5); clear smooth boundary.

Bw—18 to 30 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 50 percent gravel and 20 percent cobbles; strongly acid (pH 5.5); clear wavy boundary.

C1—30 to 38 inches; dark yellowish brown (10YR 3/4) extremely cobbly sandy loam, yellowish brown (10YR 5/4) dry; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; few very fine and fine tubular pores; 30 percent cobbles and 40 percent gravel; moderately acid (pH 5.6); clear wavy boundary.

C2—38 to 60 inches; dark yellowish brown (10YR 3/4) extremely cobbly sandy loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, nonsticky and nonplastic; 30 percent cobbles, 30 percent gravel, and 15 percent stones; moderately acid (pH 5.6)

Depth to andesite is more than 60 inches. The particle-size control section is 45 to 80 percent rock fragments and 10 to 15 percent clay. The profile has hue of 10YR or 7.5YR. It is moderately acid or strongly acid.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is very gravelly sandy loam, very bouldery sandy loam, or very stony sandy loam. It is 5 to 55 percent gravel, 5 to 20 percent cobbles, 0 to 30 percent stones, and 0 to 30 percent boulders.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 45 to 80 percent rock fragments, of which 30 to 50 percent is gravel and 15 to 30 percent is cobbles.

The C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loamy sand or sandy loam. It is 60 to 85 percent rock fragments, of which 20 to 30 percent is cobbles, 30 to 40 percent is gravel, and 10 to 15 percent is stones.

Pipp Series

The Pipp series consists of deep, somewhat excessively drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite and volcanic ash. Slopes are 12 to 65 percent. The mean annual precipitation is about 32 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Pipp very stony sandy loam, 30 to 65 percent slopes, in an area of woodland; 1,500 feet north and 2,500 feet west of the southeast corner of sec. 9, T. 9 S., R. 9 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A1—0 to 3 inches; very dark brown (10YR 2/2) very stony sandy loam, brown (10YR 4/3) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 30 percent stones, 10 percent cobbles, and 10 percent gravel; moderately acid (pH 5.8); clear smooth boundary.

A2—3 to 12 inches; dark brown (10YR 3/3) very stony sandy loam, yellowish brown (10YR 5/4) dry; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 30 percent stones, 10 percent cobbles, and 10 percent gravel; moderately acid (pH 5.8); clear smooth boundary.

Bw1—12 to 20 inches; brown (10YR 4/3) extremely stony sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 40 percent stones and 15 percent cobbles; moderately acid (pH 5.6); clear smooth boundary.

Bw2—20 to 32 inches; dark yellowish brown (10YR 4/4) extremely stony sandy loam, light yellowish brown (10YR 6/4) dry; moderate fine

and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 35 percent stones, 20 percent cobbles, and 20 percent gravel; strongly acid (pH 5.4); clear smooth boundary.

Bw3—32 to 51 inches; dark yellowish brown (10YR 4/4) extremely stony sandy loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 50 percent stones and 20 percent cobbles; moderately acid (pH 5.6); gradual wavy boundary.

R—51 inches; fractured andesite

Depth to bedrock is 40 to 60 inches. The profile has hue of 7.5YR or 10YR. The particle-size control section averages 10 to 18 percent clay. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It is very stony sandy loam or very cobbly sandy loam. The horizon is 10 to 40 percent stones, 5 to 40 percent cobbles, and 0 to 10 percent gravel.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 30 to 50 percent stones, 10 to 20 percent cobbles, and 0 to 10 percent gravel.

Piumpsha Series

The Piumpsha series consists of very deep, well drained soils on mountains. These soils formed in residuum and colluvium derived from andesite with a mantle of volcanic ash in the upper part. Slopes are 2 to 40 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 35 degrees F.

Typical pedon of Piumpsha gravelly sandy loam in an area of Piumpsha-Jojo complex, 2 to 30 percent slopes, in an area of woodland; 1,500 feet west and 2,500 feet south of the northeast corner of sec. 29, T. 10 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 5 inches; very dark brown (10YR 2/2) gravelly sandy loam, dark brown (10YR 4/3) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine irregular pores and common medium and coarse irregular pores; 15 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

A2—5 to 8 inches; dark brown (10YR 3/3) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure parting to weak very fine and fine granular structure; soft, friable, nonsticky and nonplastic; common very fine, fine, and medium roots and few coarse roots; common very fine, fine, and medium tubular pores; 15 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

Bw1—8 to 22 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 15 percent gravel; moderately acid (pH 6.0); clear wavy boundary.

Bw2—22 to 27 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 20 percent gravel and 5 percent cobbles; moderately acid (pH 6.0); clear smooth boundary.

2Bt1—27 to 43 inches; dark brown (10YR 4/3) gravelly loam, light yellowish brown (10YR 6/4) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common faint clay films on faces of peds and lining pores; 15 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

2Bt2—43 to 60 inches; dark brown (10YR 4/3) gravelly clay loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; very hard, very firm, sticky and plastic; common very fine and few fine roots; common very fine and few fine tubular pores; common distinct clay films on faces of peds and lining pores; 20 percent gravel; moderately acid (pH 6.0).

Depth to bedrock and depth of the solum are 60 inches or more. The particle-size control section averages less than 35 percent total rock fragments. The upper part is 10 to 15 percent clay, and the lower part is 20 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist and 3 or 4 dry. It is gravelly sandy loam or very bouldery sandy loam and is 15 to 25 percent gravel and 0 to 30 percent cobbles.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 15 to 35 percent gravel and 0 to 10 percent cobbles.

The 2Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam and is 15 to 40 percent gravel and 0 to 10 percent cobbles. The horizon is moderately acid or strongly acid.

Prill Series

The Prill series consists of moderately deep, well drained soils on foothills. These soils formed in residuum and colluvium derived dominantly from tuff and sedimentary rock. Slopes are 2 to 55 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Prill gravelly silty clay loam in an area of Prill-Kaskela-Rock outcrop complex, 2 to 30 percent slopes, in an area of rangeland; 2,500 feet east and 2,000 feet north of the southwest corner of sec. 10, T. 7 S., R. 13 E.

A—0 to 6 inches; black (10YR 2/1) gravelly silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 15 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

2Bt1—6 to 14 inches; very dark grayish brown (10YR 3/2) gravelly clay, dark grayish brown (10YR 4/2) dry; moderate coarse prismatic structure parting to strong medium and coarse subangular blocky; very hard, very firm, very sticky and very plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; many prominent clay films on faces of peds and lining pores; 20 percent gravel; neutral (pH 7.0); clear smooth boundary.

2Bt2—14 to 20 inches; dark brown (10YR 3/3) gravelly clay, brown (10YR 4/3) dry; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 25 percent gravel; neutral (pH 6.8); clear smooth boundary.

2Bt3—20 to 28 inches; dark brown (10YR 4/3) gravelly clay, brown (10YR 5/3) dry; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 30 percent gravel; neutral (pH 6.6); gradual wavy boundary.

3Bt4—28 to 35 inches; brown (10YR 4/3) extremely cobbly silty clay, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 70 percent cobbles and 5 percent gravel; slightly acid (pH 6.4); gradual wavy boundary.

3Cr—35 inches; tuff.

Depth to tuff or sedimentary rock is 20 to 40 inches. Depth to the discontinuity is 5 to 15 inches. The mollic epipedon is 20 to 30 inches thick. The profile has hue of 7.5YR or 10YR. The particle-size control section averages 50 to 60 percent clay.

The A horizon has value 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 30 to 40 percent clay and is 15 to 25 percent gravel and 0 to 5 percent cobbles.

The 2Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist and 2 to 4 dry. It is 15 to 30 percent gravel and 0 to 5 percent cobbles.

The 3Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is clay or silty clay and is 40 to 70 percent cobbles and 0 to 10 percent gravel.

Racing Series

The Racing series consists of very deep, poorly drained soils in mountain basins. These soils formed in mixed ash and alluvium derived from mixed sources. Slopes are 0 to 3 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 35 degrees F.

Typical pedon of Racing sandy loam, 0 to 3 percent slopes, in an area of woodland; 2,000 feet west and 500 feet north of the southeast corner of sec. 8, T. 9 S., R. 9 E.

Oi—3 inches to 0; organic layer of needles and twigs.

A—0 to 7 inches; dark brown (7.5YR 3/2) sandy loam, dark brown (7.5YR 5/4) dry; common distinct strong brown (7.5YR 5/6) mottles; weak medium granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; moderately acid (pH 5.8); clear smooth boundary.

Oa—7 to 11 inches; black (N 2/0) muck, rubbed and pressed, very dark gray (7.5YR 3/1) dry; about 40 percent fibers, 5 percent rubbed; weak medium platy structure; very friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; moderately acid (pH 5.8); clear smooth boundary.

Bg1—11 to 16 inches; dark gray (10YR 4/1) silt loam, light brownish gray (10YR 6/2) dry; common distinct dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores and few medium tubular pores; common faint organic coatings on faces of peds and lining pores; 5 percent gravel; moderately acid (pH 5.6); clear smooth boundary.

Bg2—16 to 22 inches; light brownish gray (10YR 6/2) silty clay loam, white (10YR 8/1) dry; many distinct yellowish brown (10YR 5/6) mottles; strong coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; moderately acid (pH 5.6); clear smooth boundary.

2Bg3—22 to 30 inches; light brownish gray (10YR 6/2) very gravelly clay loam, light gray (10YR 7/1) dry; many distinct dark yellowish brown (10YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; 40 percent gravel; moderately acid (pH 5.6); gradual wavy boundary.

2Bg4—30 to 41 inches; light brownish gray (10YR 6/2) extremely gravelly loam, light gray (10YR 7/2) dry; many distinct dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; 60 percent gravel; moderately acid (pH 5.6); clear wavy boundary.

3Cg1—41 to 51 inches; grayish brown (10YR 5/2) extremely gravelly sand, very pale brown (10YR 7/3) dry; many distinct dark yellowish brown (10YR 4/6) mottles; weakly cemented with iron; massive; very hard, very firm, nonsticky and nonplastic; 80 percent gravel; 20 percent iron-manganese concretions; moderately acid (pH 5.6) clear wavy boundary.

3Cg2—51 to 60 inches; grayish brown (10YR 5/2) very gravelly sandy loam, light gray (10YR 7/1) dry; many distinct dark yellowish brown (10YR 4/6) mottles; massive; hard; firm, slightly sticky and slightly plastic; 50 percent gravel; moderately acid (pH 5.6).

Depth to the weakly cemented substratum is 40 to 60 inches. Depth to bedrock is more than 60 inches. The particle-size control section averages 20 to 30 percent clay, more than 15 percent fine sand or coarser material, and less than 35 percent total rock fragments. The profile is mottled throughout.

The A horizon has value of 2 or 3 moist and 3 to 5 dry, and it has chroma of 2 or 3 moist and 3 or 4 dry. It has moist bulk density of 0.80 to 0.90 grams per centimeter and has andic properties.

The Oa horizon, where present, has value of 2 or 3 moist or dry and chroma of 0 to 2 moist or dry.

The Bg horizon has value of 4 to 6 moist and 6 to 8 dry, and it has chroma of 1 or 2 moist or dry. It is silt loam or silty clay loam and is 0 to 5 percent gravel.

The 2Bg horizon has value of 5 or 6 moist and 7 or 8 dry, and it has chroma of 1 or 2 moist or dry. It is clay loam or loam and is 35 to 80 percent gravel.

The 3Cg1 horizon has value of 5 or 6 moist and 7 or 8 dry, and it has chroma of 1 or 2 moist and 2 or 3 dry. It is 60 to 85 percent gravel and 15 to 25 percent iron-manganese concretions.

The 3Cg2 horizon has value of 5 or 6 moist and 7 or 8 dry, and it has chroma of 1 or 2 moist or dry. It is sandy loam or loam and is 35 to 80 percent gravel.

Rockly Series

The Rockly series consists of very shallow, well drained soils on mesas. These soils formed in colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 0 to 30 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Rockly very stony silt loam in an area of Watama-Rockly complex, 0 to 8 percent slopes, in an area of rangeland; 1,900 feet east and 2,100 feet south of the northwest corner of sec. 8, T. 9 S., R. 12 E.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) very stony silt loam, grayish brown (10YR 5/2) dry; weak thin and medium platy structure; soft,

very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 40 percent stones and 10 percent cobbles; neutral (pH 6.6); clear smooth boundary.

Bw1—3 to 7 inches; dark brown (10YR 3/3) very cobbly silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 35 percent cobbles and 15 percent gravel; neutral (pH 6.6); clear smooth boundary.

Bw2—7 to 9 inches; dark brown (10YR 3/3) extremely cobbly silty clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; 50 percent cobbles and 25 percent gravel; neutral (pH 6.8); abrupt wavy boundary.

2R—9 inches; basalt.

Depth to bedrock is 4 to 10 inches. The particle-size control section averages 20 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 30 percent stones, 10 to 20 percent cobbles, and 10 to 55 percent gravel.

The Bw horizon has chroma of 2 to 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam or silty clay loam and is 30 to 50 percent cobbles and 15 to 25 percent gravel. In some pedons, faint clay films line pores in a thin layer above the bedrock.

Ruckles Series

The Ruckles series consists of shallow, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt or tuff. Slopes are 2 to 80 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Ruckles very cobbly loam in an area of Ruclick-Ruckles complex, 12 to 30 percent slopes, in an area of rangeland; 1,000 feet west and 1,500 feet north of the southeast corner of sec. 1, T. 9 S., R. 12 E.

A—0 to 4 inches; very dark brown (10YR 2/2) very cobbly loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 30 percent cobbles and 15 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt1—4 to 8 inches; very dark brown (10YR 2/2) extremely gravelly clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; common distinct films on faces of peds; 20 percent cobbles and 45 percent gravel; neutral (pH 6.8); abrupt smooth boundary.

Bt2—8 to 18 inches; dark brown (10YR 3/3) very gravelly clay, brown (10YR 5/3) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 15 percent cobbles and 35 percent gravel; neutral (pH 6.6); clear smooth boundary.

R—18 inches; tuff.

Depth to bedrock is 10 to 20 inches. The particle-size control section averages 35 to 60 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is very cobbly loam, very stony loam, or very cobbly silt loam. It is 15 to 30 percent cobbles, 0 to 20 percent stones, and 5 to 20 percent gravel.

The Bt1 horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is clay loam or clay. It is 25 to 45 percent gravel, 10 to 20 percent cobbles, and 0 to 10 percent stones.

The Bt2 horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 25 to 45 percent gravel, 10 to 20 percent cobbles, and 0 to 20 percent stones.

Ruclick Series

The Ruclick series consists of moderately deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt or tuff. Slopes are 12 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Ruclick very stony loam in an area of Ruclick-Ruckles complex, 30 to 55 percent slopes, in an area of rangeland; 2,000 feet north and 1,500 feet west of the southeast corner of sec. 21, T. 8 S., R. 13 E.

A—0 to 4 inches; very dark brown (10YR 2/2) very stony loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, friable, nonsticky and

nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 25 percent stones, 25 percent cobbles, and 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt1—4 to 14 inches; very dark grayish brown (10YR 3/2) very cobbly silty clay loam, brown (10YR 5/3) dry; strong medium and coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; 30 percent cobbles and 20 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bt2—14 to 24 inches; dark brown (10YR 4/3) very cobbly clay, yellowish brown (10YR 5/4) dry; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 30 percent cobbles and 20 percent gravel; neutral (pH 6.6); clear smooth boundary.

Bt3—24 to 37 inches; brown (10YR 4/3) extremely cobbly clay, pale brown (10YR 6/3) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds; 30 percent cobbles and 30 percent gravel; neutral (pH 6.6); clear smooth boundary.

R—37 inches; basalt.

Depth to bedrock is 20 to 40 inches. The particle-size control section averages 35 to 50 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 10 to 30 percent stones, 15 to 25 percent cobbles, and 5 to 15 percent gravel.

The Bt1 horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It is clay loam or silty clay loam. The horizon is 20 to 40 percent cobbles, 10 to 20 percent gravel, and 0 to 5 percent stones.

The Bt2 and Bt3 horizons have value of 3 or 4 moist and 5 or 6 dry, and they have chroma of 3 or 4 moist or dry. They are 30 to 40 percent cobbles, 10 to 30 percent gravel, and 0 to 5 percent stones.

Sagley Series

The Sagley series consists of deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 12 to 55 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Sagley silt loam in an area of Sagley-Kishwalk complex, 30 to 55 percent slopes, in an area of rangeland; 600 feet north and 1,500 feet east of the southwest corner of sec. 28, T. 8 S., R. 12 E.

A—0 to 7 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

AB—7 to 18 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 5 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bt1—18 to 26 inches; very dark grayish brown (10YR 3/2) very cobbly clay loam, brown (10YR 4/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; few faint clay films on faces of peds and lining pores; 30 percent cobbles and 15 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bt2—26 to 34 inches; very dark grayish brown (10YR 3/2) cobbly clay loam, brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores; common faint clay films on faces of peds and lining pores; 15 percent cobbles and 15 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bt3—34 to 50 inches; dark brown (10YR 3/3) very cobbly clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 40 percent cobbles and 15 percent gravel; neutral (pH 6.8); abrupt wavy boundary.

R—50 inches; basalt.

Depth to bedrock is 40 to 60 inches. The particle-size control section averages 27 to 35 percent clay and more than 35 percent total rock fragments. The mollic epipedon is 20 to 30 inches thick.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 0 to 10 percent gravel.

The Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam and is 15 to 50 percent cobbles and 10 to 25 percent are gravel.

Shiva Series

The Shiva series consists of very deep, well drained soils in canyons. They formed in residuum and colluvium derived dominantly from volcanic ash and pumice. Slopes are 0 to 55 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Shiva fine sandy loam, 30 to 55 percent slopes, in an area of rangeland; 300 feet east and 1,100 feet north of the southwest corner of sec. 23, T. 9 S., R. 11 E.

A—0 to 4 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 5 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.4); clear smooth boundary.

BA—4 to 9 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 5 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.

Bw1—9 to 18 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 10 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.4); clear smooth boundary.

Bw2—18 to 28 inches; dark brown (10YR 3/3) gravelly fine sandy loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 15 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.4); clear smooth boundary.

Bw3—28 to 44 inches; dark brown (10YR 3/3) gravelly fine sandy loam, pale brown (10YR 6/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 20 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.6); clear smooth boundary.

C—44 to 60 inches; brown (10YR 3/3) very gravelly fine sandy loam, pale brown (10YR 6/3) dry; massive; hard, firm, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 35 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; mildly alkaline (pH 7.6).

Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 10 to 18 percent clay.

The A horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 1 or 2 moist or dry. It is 5 to 10 percent gravel-sized pumice and 5 to 20 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is loam or fine sandy loam. The horizon is 5 to 25 percent gravel-sized pumice and 10 to 25 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or fine sandy loam and is 20 to 40 percent gravel-sized pumice and 15 to 30 percent pumice that is 0.5 to 2.0 millimeters in diameter.

Simas Series

The Simas series consists of very deep, well drained soils on foothills. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of loess in the upper part. Slopes are 2 to 80 percent. The mean

annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Simas silt loam in an area of Simas-Antoken complex, 2 to 30 percent slopes, in an area of rangeland; 2,000 feet west and 2,500 feet south of the northeast corner of sec. 2, T. 8 S., R. 13 E.

A1—0 to 3 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine irregular pores; neutral (pH 7.0); clear smooth boundary.

A2—3 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; neutral (pH 7.2); abrupt smooth boundary.

2Bt1—9 to 18 inches; dark brown (10YR 3/3) clay, dark brown (10YR 4/3) dry; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 5 percent gravel; mildly alkaline (pH 7.4); gradual smooth boundary.

2Bt2—18 to 26 inches; dark brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 5 percent gravel; moderately alkaline (pH 8.4); abrupt smooth boundary.

2Btk—26 to 35 inches; dark brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; strongly effervescent with segregated lime in soft masses and seams; 10 percent gravel; moderately alkaline (pH 8.4); clear smooth boundary.

2Bk1—35 to 46 inches; yellowish brown (10YR 5/4) gravelly clay loam, very pale brown (10YR 7/3) dry; massive; hard, friable, nonsticky and nonplastic; strongly effervescent with disseminated lime; 30 percent gravel; moderately alkaline (pH 8.4); gradual smooth boundary.

2Bk2—46 to 60 inches; yellowish brown (10YR 5/4) gravelly clay loam, very pale brown (10YR 7/3) dry; massive; hard, friable, nonsticky and nonplastic; violently effervescent with disseminated lime; 15 percent gravel; moderately alkaline (pH 8.4).

Depth to bedrock is more than 60 inches. The particle-size control section averages 50 to 60 percent clay. The mollic epipedon is 10 to 20 inches thick, and it may include the upper part of the argillic horizon.

The A horizon has value 2 or 3 moist and 4 or 5 dry. It is silt loam, cobbly silt loam, or very stony loam. The horizon is 0 to 20 percent gravel, 0 to 20 percent cobbles, and 0 to 20 percent stones.

The 2Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 15 percent gravel and 0 to 10 percent cobbles.

The 2Btk horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 20 percent gravel and 0 to 15 percent cobbles.

The 2Bk1 horizon has value of 4 or 5 moist and 6 or 7 dry, and it has chroma of 3 or 4 moist or dry. It is clay or clay loam and is 15 to 40 percent gravel and 0 to 15 percent cobbles. The horizon is strongly effervescent to violently effervescent.

Simnasho Series

The Simnasho series consists of moderately deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash in the upper part. Slopes are 0 to 40 percent. The mean annual precipitation is about 32 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Simnasho very stony sandy loam in an area of Smiling-Simnasho complex, high precipitation, 0 to 12 percent slopes, in an area of woodland; 2,000 feet west and 500 feet north of the southeast corner of sec. 35, T. 10 S., R. 9 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A—0 to 7 inches; dark brown (7.5YR 3/2) very stony sandy loam, brown (7.5YR 4/3) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine irregular pores and few medium and coarse irregular pores; 30 percent stones and 20 percent cobbles; moderately acid (pH 6.0); clear smooth boundary.

AB—7 to 16 inches; dark brown (7.5YR 3/4) very stony sandy loam, brown (7.5YR 5/4) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 30 percent stones and 20 percent cobbles; slightly acid (pH 6.2); clear smooth boundary.

Bw—16 to 24 inches; dark brown (7.5YR 3/4) very cobbly sandy loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 30 percent cobbles; 10 percent stones; slightly acid (pH 6.2); clear smooth boundary.

2Btb—24 to 33 inches; dark yellowish brown (10YR 4/4) extremely cobbly loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few fine and medium roots; few fine and medium tubular pores; common distinct clay films on faces of peds and lining pores; 45 percent cobbles and 20 percent stones; slightly acid (pH 6.4); gradual wavy boundary.

2Cr—33 inches; weathered andesite.

Depth to weathered andesite is 20 to 40 inches. The profile has hue of 7.5YR or 10YR. The particle-size control section is 35 to 85 percent rock fragments. The upper part is 10 to 15 percent clay, and the lower part is 25 to 35 percent clay. The horizon is slightly acid or moderately acid.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is very stony sandy loam or very cobbly sandy loam, and is 5 to 40 percent stones, 10 to 30 percent cobbles, and 0 to 10 percent gravel.

Texture of the AB horizon is similar to that of the A horizon. The AB horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 5 percent gravel, 20 to 40 percent cobbles, and 10 to 20 percent stones.

The 2Btb horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam. The horizon is 0 to 5 percent gravel, 30 to 50 percent cobbles, and 10 to 25 percent stones.

Skooker Series

The Skooker soils consists of deep, well drained soils on outwash plains. These soils formed in glacial outwash with an influence of volcanic ash. Slopes are 0 to 20 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Skooker gravelly loam, 8 to 20 percent slopes, in an area of woodland; 1,500 feet east and 300 feet south of the northwest corner of sec. 29, T. 7 S., R. 11 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 4 inches; very dark brown (10YR 2/2) gravelly loam, dark brown (10YR 4/3) dry; moderate thick platy structure parting to moderate coarse granular; soft, friable, nonsticky and nonplastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine irregular pores and few medium and coarse irregular pores; 20 percent gravel; neutral (pH 7.0); clear wavy boundary.

A2—4 to 16 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate medium and coarse subangular blocky structure parting to moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; 20 percent gravel; neutral (pH 6.8); clear smooth boundary.

Bt1—16 to 31 inches; dark brown (10YR 3/3) gravelly silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; common distinct clay films on faces of peds; 30 percent gravel; slightly acid (pH 6.3); gradual smooth boundary.

Bt2—31 to 50 inches; dark brown (10YR 3/3) extremely cobbly silty clay loam, brown (10YR 5/3) dry, moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and medium tubular pores; common distinct clay films on faces of peds; 25 percent cobbles and 40 percent gravel; slightly acid (pH 6.3); gradual wavy boundary.

2Cr—50 inches; highly fractured sandstone.

Depth to bedrock is 40 to 60 inches. The profile has hue of 7.5YR or 10YR. The mollic epipedon is 20 to 30 inches thick, and it may include the upper part of the argillic horizon. The particle-size control section averages 27 to 35 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 30 percent gravel and 0 to 10 percent cobbles. It is 2 to 3 percent organic matter.

The Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is silty clay loam or clay loam. The Bt1 horizon is 20 to 30 percent gravel and 0 to 10 percent cobbles. The Bt2 horizon is 25 to 35 percent cobbles and 30 to 40 percent gravel.

Skoven Series

The Skoven series consists of shallow, well drained soils on low foothills. These soils formed in loess and colluvium over sedimentary rock or tuff. Slopes are 0 to 15 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Skoven extremely gravelly silt loam in an area of Skoven-Lavey complex, 2 to 15 percent slopes, in an area of rangeland; 1,000 feet south and 2,500 feet west of the northeast corner of sec. 9, T. 8 S., R. 13 E.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) extremely gravelly silt loam, brown (10YR 5/3) dry; moderate medium platy structure parting to weak fine subangular blocky; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 70 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt1—3 to 8 inches; dark brown (10YR 3/3) very gravelly silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 50 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt2—8 to 11 inches; reddish brown (5YR 4/4) extremely gravelly clay, yellowish red (5YR 5/6) dry; strong fine and medium subangular blocky structure; hard, firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; continuous prominent clay films on faces of peds and lining pores; 70 percent gravel; neutral (pH 6.8); abrupt smooth boundary.

2Crkq—11 to 21 inches; paralithic tuff with coatings of silica and calcium carbonate.

2R—21 inches; welded tuff of the Deschutes Formation

Depth to bedrock is 10 to 20 inches. The particle-size control section averages 35 to 45 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 60 to 80 percent gravel. It is 10 to 30 percent volcanic glass.

The Bt horizon has hue of 5YR, 7.5YR or 10YR; value of 3 or 4 moist and 4 or 5 dry; and chroma of 3 to 6 moist or dry. It is silty clay loam or clay and is 40 to 70 percent gravel.

The 2Crkq horizon is paralithic tuff or waterlain sediment of the Deschutes Formation.

Smiling Series

The Smiling series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from andesite with a mantle of volcanic ash in the upper part. Slopes are 0 to 12 percent. The mean annual precipitation is about 32 inches, and the mean annual air temperature is about 43 degrees F.

Typical pedon of Smiling sandy loam, in an area of Smiling-Simnasho complex, high precipitation, 0 to 12 percent slopes, in an area of woodland; 1,300 feet east and 500 feet north of the southwest corner of sec. 3, T. 11 S., R. 9 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 3 inches; dark brown (7.5YR 3/2) sandy loam, brown (7.5YR 4/3) dry; weak medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine irregular pores and common medium irregular pores; 3 percent gravel; moderately acid (pH 6.0); clear smooth boundary.

A2—3 to 9 inches; dark brown (7.5YR 3/2) sandy loam, brown (7.5YR 4/3) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and common medium roots; many very fine and fine tubular pores and common medium tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

Bw1—9 to 15 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

Bw2—15 to 33 inches; dark brown (7.5YR 3/4) sandy loam, brown (7.5YR 5/4) dry; moderate medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine tubular pores and few medium and coarse tubular pores; 10 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

2Btb1—33 to 43 inches; brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) dry; moderate medium subangular structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common faint clay films on faces of peds; 20 percent gravel and 5 percent cobbles; moderately acid (pH 6.0); gradual wavy boundary.

2Btb2—43 to 56 inches; brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) slightly hard, firm; slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and few fine tubular pores; common distinct clay films on faces of peds and lining pores; 20 percent gravel and 10 percent cobbles; moderately acid (pH 6.0); clear smooth boundary.

2Cr—56 inches; weathered andesite.

Depth to weathered andesite is 40 to 60 inches. The profile has hue of 10YR or 7.5YR. The upper part of the particle-size control section is 10 to 15 percent clay, and the contrasting, lower part is 25 to 35 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles.

The 2Btb horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is loam or clay loam and is 10 to 20 percent gravel and 0 to 10 percent cobbles.

Sorf Series

The Sorf series consists of moderately deep, well drained soils on foothills. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of loess. Slopes are 2 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Sorf very gravelly loam in an area of Sorf-Simas complex, 2 to 30 percent slopes, in an area of rangeland; 4,000 feet east and 4,050 feet south of the northwest corner of sec. 3, T. 8 S., R. 13 E.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 40 percent gravel and 10 percent cobbles; neutral (pH 6.6); clear smooth boundary.

A2—2 to 6 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 35 percent gravel; neutral (pH 7.0); abrupt wavy boundary.

2Bt1—6 to 17 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; strong coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 5 percent gravel; neutral (pH 7.0); gradual wavy boundary.

2Bt2—17 to 23 inches; strong brown (7.5YR 4/6) clay, brown (7.5YR 5/4) dry; strong medium and coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; continuous prominent clay films on faces of peds and lining pores; mildly alkaline (pH 7.6); clear wavy boundary.

2Btk—23 to 26 inches; dark yellowish brown (10YR 4/6) clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; strongly effervescent; soft masses of segregated lime; moderately alkaline (pH 8.2); clear wavy boundary.

2Cr—26 inches; calcareous tuff; violently effervescent with disseminated lime.

Depth to tuff ranges from 20 to 40 inches. Depth to the discontinuity is 5 to 15 inches. The particle-size control section averages 50 to 60 percent clay and less than 35 percent total rock fragments. The profile has hue of 7.5YR or 10YR.

The A horizon has value 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 35 to 50 percent gravel and 0 to 10 percent cobbles.

The 2Bt horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 4 to 6 moist or dry. It is 0 to 10 percent gravel.

The 2Btk horizon or the 2Bk horizon, where present, has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 5 or 6 moist or dry. It is 0 to 10 percent gravel. It is strongly effervescent or violently effervescent.

Spilyay Series

The Spilyay series consists of very deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from semiconsolidated conglomerate and tuff. Slopes are 0 to 30 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Spilyay very cobbly loam in an area of Spilyay-Bodell complex, 2 to 30 percent slopes, 1,500 feet west and 2,500 north of the southeast corner of sec. 16, T. 10 S., R. 11 E.

Oi—1 inch to 0; organic layer of needles and twigs.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) very cobbly loam, grayish brown (10YR 5/2) dry; moderate medium granular structure parting to moderate very fine subangular blocky; soft, friable, nonsticky and nonplastic; common very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 25 percent cobbles and 20 percent gravel; neutral (pH 6.8); abrupt smooth boundary.

2Bt1—8 to 15 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, medium, and coarse roots; common very fine, fine, medium, and coarse tubular pores; common distinct clay films on faces of peds and lining pores; 10 percent gravel; neutral (pH 6.8); clear smooth boundary.

2Bt2—15 to 21 inches; brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; strong medium prismatic structure parting to moderate coarse subangular blocky structure; very hard, very firm, sticky and plastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; neutral (pH 6.8); clear smooth boundary.

2Bt3—21 to 32 inches; dark yellowish brown (10YR 4/4) clay, light yellowish brown (10YR 6/4) dry; strong medium subangular blocky structure; very hard, very firm, sticky and plastic; common very fine and fine roots and few medium and coarse roots; common very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 5 percent gravel; neutral (pH 7.0); gradual wavy boundary.

2Bt4—32 to 41 inches; dark yellowish brown (10YR 4/4) clay, light yellowish brown (10YR 6/4) dry; moderate medium and coarse subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 5 percent gravel; neutral (pH 7.0); gradual wavy boundary.

2BCt—41 to 60 inches; brown (10YR 4/3) silt loam, light yellowish brown (10YR 6/4) dry; massive; hard, firm, slightly sticky and slightly plastic; common distinct clay films along broken planes; 5 percent gravel; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 15 inches thick. The particle-size control section averages 35 to 55 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 20 to 30 percent cobbles and 15 to 25 percent gravel.

The 2Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is 0 to 10 percent gravel.

The 2BCt horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam or loam and is 0 to 10 percent gravel.

Suppah Series

The Suppah series consists of soils that are moderately deep to pumice and are somewhat excessively drained. These soils are in canyons. They formed in residuum and colluvium derived dominantly from volcanic ash and pumice. Slopes are 12 to 30 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Suppah very gravelly sandy loam, 12 to 30 percent slopes, in an area of rangeland; 2,200 feet west and 1,400 feet south of the northeast corner of sec. 10, T. 10 S., R. 12 E.

A—0 to 3 inches; very dark brown (10YR 2/2) very gravelly sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; 50 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 6.8); clear smooth boundary.

AB—3 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly sandy loam, pale brown (10YR 6/3) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 45 percent gravel-sized pumice and 10 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 7.1); clear smooth boundary.

Bw1—10 to 18 inches; dark grayish brown (10YR 4/2) very gravelly sandy loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine tubular pores and few medium tubular pores; 55 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; neutral (pH 7.3); clear smooth boundary.

Bw2—18 to 26 inches; dark brown (10YR 3/3) extremely gravelly sandy loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; slightly effervescent with disseminated lime; 70 percent gravel-sized pumice and 15 percent pumice that is 0.5 to 2.0 millimeters in diameter; slightly acid (pH 6.5); abrupt wavy boundary.

C—26 to 60 inches; light gray (10YR 7/2) pumice, white (10YR 8/2) dry.

Depth to bedrock is more than 60 inches. Depth to fragmental pumice is 20 to 40 inches. The upper 20 to 40 inches of the particle-size control section averages 5 to 10 percent clay.

The A horizon has value of 2 or 3 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is 45 to 55 percent gravel-sized pumice and 5 to 15 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The Bw horizon has value of 3 or 4 moist and 6 or 7 dry, and it has chroma of 2 or 3 moist or dry. It is sandy loam or loamy sand. It is 45 to 80 percent gravel-sized pumice and 10 to 20 percent pumice that is 0.5 to 2.0 millimeters in diameter.

The C horizon has value of 7 or 8 moist or dry, and it has chroma of 2 or 3 moist or dry. It is fragmental pumice and is less than 10 percent particles that are less than 2 millimeters in diameter.

Teewee Series

The Teewee series consists of deep, well drained soils on mountains. These soils formed in residuum and colluvium derived from andesite or basalt with an influence of volcanic ash. Slopes are from 0 to 12 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Teewee loam, 0 to 3 percent slopes, in an area of woodland, 2,500 feet west and 1,600 feet south of the northeast corner of sec. 36, T. 8 S., R. 10 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 4 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; weak fine subangular blocky structure parting to weak fine granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular pores; moderately acid (pH 6.0); clear smooth boundary.

A2—4 to 11 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine, fine, and medium roots and few coarse roots; common very fine, fine, and medium tubular pores and few coarse tubular pores; 5 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

Bt1—11 to 18 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; common distinct clay films on faces of peds; 5 percent gravel; slightly acid (pH 6.4); clear wavy boundary.

Bt2—18 to 27 inches; dark brown (7.5YR 3/4) clay loam, brown (7.5YR 5/4) dry; moderate medium

and coarse subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common very fine, fine, and medium tubular pores; common distinct clay films on faces of peds; 10 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

Bt3—27 to 43 inches; dark brown (7.5YR 3/4) clay loam, brown (7.5YR 5/4) dry; moderate medium and coarse subangular blocky structure; very hard, firm, sticky and plastic; few very fine and fine roots; few very fine and fine tubular pores; many distinct clay films on faces of peds; 10 percent gravel; neutral (pH 6.6); clear smooth boundary.

Bt4—43 to 53 inches; dark brown (7.5YR 3/4) very stony clay loam, brown (7.5YR 5/4) dry; weak medium and coarse subangular blocky structure; very hard, very firm, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; common distinct clay films on faces of peds; 20 percent stones, 20 percent cobbles, and 10 percent gravel; neutral (pH 6.6); gradual wavy boundary.

2Cr—53 inches; weathered andesite.

Depth to weathered bedrock is 40 to 60 inches. The profile has hue of 7.5YR or 10YR. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 25 to 35 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel and 0 to 10 percent cobbles. It is 2 to 4 percent organic matter.

The Bt1, Bt2, and Bt3 horizons have value of 3 or 4 moist and 5 or 6 dry, and they have chroma of 3 or 4 moist or dry. They are loam or clay loam and are 0 to 10 percent gravel and 0 to 10 percent cobbles.

The Bt4 horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 4 or 5 moist or dry. It is 0 to 15 percent gravel, 10 to 20 percent cobbles, and 10 to 20 percent stones.

Tenwalter Series

The Tenwalter series consists of soils that are shallow to a duripan and are well drained. These soils are on outwash plains. They formed in glacial outwash with an influence of loess in the upper part. Slopes are 0 to 3 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Tenwalter very cobbly silt loam in an area of Milldam-Tenwalter complex, 0 to 3 percent slopes, in an area of rangeland; 2,200 feet west and 1,300 feet north of the southeast corner of sec. 18, T. 8 S., R. 11 E.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) very cobbly silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 30 percent cobbles and 20 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

BA—3 to 11 inches; dark brown (10YR 3/3) very cobbly silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent cobbles and 10 percent gravel; slightly acid (pH 6.2); clear smooth boundary.

2Bt—11 to 15 inches; dark brown (7.5YR 3/4) extremely cobbly clay, brown (7.5YR 5/4) dry; strong fine subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 50 percent cobbles and 15 percent gravel; slightly acid (pH 6.4); abrupt smooth boundary.

2Btqm—15 to 27 inches; duripan; indurated and strongly cemented; extremely hard and very brittle; silica cap 1 millimeter thick; many prominent clay films in fractures; pendants of clay and silica on bottom of fractures; neutral (pH 7.2); abrupt wavy boundary.

2Btq—27 to 60 inches; brown (7.5YR 4/4) extremely cobbly clay, brown (7.5YR 4/4) dry; massive; hard, firm and brittle, sticky and plastic; weak silica cementation; many prominent clay films on faces of rock fragments; 60 percent cobbles and 20 percent gravel; neutral (pH 7.0).

Depth to the duripan is 10 to 20 inches. Depth to bedrock is more than 60 inches. The mollic epipedon is 10 to 15 inches thick. The particle-size control section averages 35 to 45 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 25 to 40 percent cobbles and 10 to 20 percent gravel.

The 2Bt horizon has hue of 7.5YR or 10YR, value of 3 or 4 moist and 4 to 6 dry, and chroma of 3 or 4 moist or dry. It is silty clay loam or clay and is 40 to 60 percent cobbles and 10 to 20 percent gravel.

The 2Btqm horizon is indurated with 1- to 2-millimeter-thick laminar bands, or it is strongly cemented and is indurated in the upper part. It is 10 to 25 inches thick.

The 2Btq horizon has hue of 7.5YR to 10YR, value of 4 to 6 moist or dry, and chroma of 4 or 5 moist or dry. It is clay or silty clay and is 40 to 60 percent cobbles and 10 to 20 percent gravel. The horizon is weakly cemented or strongly cemented.

Tolius Series

The Tolius series consists of very deep, well drained soils on outwash plains. These soils formed in glacial outwash with an influence of volcanic ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Tolius loam, 0 to 8 percent slopes, in an area of woodland; 650 feet east and 200 feet north of the southwest corner of sec. 6, T. 9 S., R. 11 E.

Oi—2 inches to 0; organic layer of needles and twigs.

A1—0 to 5 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; neutral (pH 6.6); clear smooth boundary.

A2—5 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; neutral (pH 6.6); clear smooth boundary.

A3—11 to 23 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; neutral (pH 6.8); clear smooth boundary.

Bt1—23 to 35 inches; dark brown (10YR 3/3) sandy clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; common distinct clay films on faces of peds and lining pores; neutral (pH 6.8); clear smooth boundary.

Bt2—35 to 49 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; few faint clay films on faces of peds and lining pores; neutral (pH 6.8); clear smooth boundary.

C—49 to 60 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, nonsticky and nonplastic; common fine and medium roots; common fine tubular pores; 10 percent gravel; neutral (pH 7.0).

Depth to bedrock is more than 60 inches. A weakly cemented duripan is below a depth of 60 inches in some pedons. The mollic epipedon is 20 to 30 inches thick, and it may include the upper part of the argillic horizon. The particle-size control section averages 18 to 30 percent clay. It is slightly acid or neutral.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel and 2 to 3 percent organic matter.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is sandy loam, loam, or sandy clay loam and is 0 to 15 percent gravel.

The C horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 to 6 moist or dry. It is loam or sandy loam and is 10 to 30 percent gravel and 0 to 15 percent cobbles.

Typic Vitricryands

Typic Vitricryands are moderately deep to deep, excessively drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from pyroclastic ashflow, andesite, and volcanic ash. Slopes are 2 to 70 percent. The mean annual precipitation is about 95 inches, and the mean annual air temperature is about 35 degrees F.

Reference pedon of Typic Vitricryands, 2 to 70 percent slopes; 2,500 feet south and 2,500 feet west of the northeast corner of sec. 25, T. 10 S., R. 8 E.

A—0 to 8 inches; dark brown (10YR 3/3) extremely stony sandy loam, brown (10YR 4/3) dry; weak fine and medium subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots and few medium roots; many very fine and fine irregular pores and few medium irregular

pores; 30 percent stones, 20 percent cobbles, and 20 percent gravel; moderately acid (pH 5.8); clear wavy boundary.

2C1—8 to 18 inches; very dark gray (10YR 3/1) extremely cobbly loamy sand, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel, 30 percent cobbles, and 5 percent stones; moderately acid (pH 5.6); clear smooth boundary.

2C2—18 to 29 inches; very dark grayish brown (10YR 3/2) extremely cobbly sand, pale brown (10YR 6/3) dry; loose; nonsticky and nonplastic; few very fine and fine roots; 40 percent cobbles, 30 percent gravel, and 5 percent stones; moderately acid (pH 5.6); abrupt wavy boundary.

3Cr—29 inches; very dark brown (10YR 2/2) pyroclastic ashflow.

Depth to bedrock is 20 to 60 inches.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It typically is sandy loam. The horizon is 30 to 40 percent stones, 10 to 30 percent cobbles, and 10 to 40 percent gravel.

The 2C horizon has value of 3 or 4 moist and 4 to 6 dry, and it has chroma of 1 to 3 moist or dry. It is sandy loam, loamy sand, or sand. The horizon is 30 to 50 percent cobbles, 10 to 30 percent gravel, and 0 to 20 percent stones.

The 3Cr horizon is pyroclastic ashflow or highly weathered andesite.

Venator Series

The Venator series consists of shallow, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock. Slopes are 2 to 80 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Venator extremely channery loam in an area of Venator-Rock outcrop complex, 2 to 30 percent slopes, in an area of rangeland; 1,300 feet east and 100 feet north of the southwest corner of sec. 1, T. 8 S., R. 12 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) extremely channery loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 65 percent channers; neutral (pH 7.0); clear smooth boundary.

AB—4 to 7 inches; dark brown (10YR 3/3) very channery loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 50 percent channers; neutral (pH 6.8); clear smooth boundary.

Bw1—7 to 13 inches; dark brown (10YR 3/3) very channery loam, brown (10YR 4/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 50 percent channers; neutral (pH 6.6); clear smooth boundary.

Bw2—13 to 18 inches; dark yellowish brown (10YR 3/4) extremely channery loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 75 percent channers; slightly acid (pH 6.4); gradual wavy boundary.

R—18 inches; fractured sedimentary rock.

Depth to bedrock is 12 to 20 inches. The mollic epipedon is 7 to 15 inches thick. The particle-size control section averages 15 to 25 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 60 to 70 percent channers.

The Bw horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist and dry. It is 50 to 75 percent channers.

Vitrandic Haploxerolls

Vitrandic Haploxerolls are very deep, well drained to somewhat excessively drained soils in narrow drainageways of mountains. These soils formed in medium- to coarse-textured alluvium derived from mixed sources with an influence of volcanic ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 28 inches, and the mean annual air temperature is about 45 degrees F.

Reference pedon of Vitrandic Haploxerolls, 0 to 8 percent slopes; 2,000 feet north and 1,000 feet east of the southwest corner of sec. 26, T. 7 S., R. 10 E.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many very

fine and fine roots; many very fine and fine tubular pores; 25 percent gravel and 10 percent cobbles; moderately acid (pH 5.8); clear smooth boundary.
AB—5 to 11 inches; dark brown (10YR 3/3) very gravelly sandy loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure parting to weak fine granular; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel, 10 percent cobbles, and 5 percent stones; moderately acid (pH 6.0); clear smooth boundary.
Bw1—11 to 20 inches; dark brown (10YR 3/3) extremely gravelly loamy sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 40 percent gravel, 15 percent cobbles, and 10 percent stones; slightly acid (pH 6.4); clear smooth boundary.
Bw2—20 to 35 inches; dark brown (10YR 4/3) very gravelly silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; 40 percent gravel and 10 percent cobbles; neutral (pH 6.6); clear wavy boundary.
C—35 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly sandy clay loam, yellowish brown (10YR 5/4) dry; massive; hard, firm, slightly sticky and slightly plastic; few very fine roots; 40 percent gravel and 10 percent cobbles; neutral (pH 7.2).

Depth to bedrock is more than 60 inches.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 to 3 moist or dry. It typically is loam. The horizon is 20 to 40 percent gravel, 10 to 20 percent cobbles, and 0 to 5 percent stones.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 or 3 moist or dry. It is sandy loam, loamy sand, loam, or silt loam. The horizon is 25 to 50 percent gravel, 10 to 20 percent cobbles, and 0 to 10 percent stones.

The C horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is sandy clay loam, clay loam, sandy loam, or loam. The horizon is 30 to 60 percent gravel, 10 to 30 percent cobbles, and 0 to 10 percent stones.

Wakamo Series

The Wakamo series consists of shallow, well drained soils on mountains. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash. Slopes are 2 to 30 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Wakamo very gravelly loam in an area of Wakamo-Rock outcrop complex, 2 to 30 percent slopes, in an area of woodland; 3,000 east and 800 feet south of the northwest corner of sec. 14, T. 7 S., R. 13 E.

Oi—1 inch to 0; organic layer of needles and twigs.
A1—0 to 3 inches; very dark grayish brown (10YR 3/2) very gravelly loam, light brownish gray (10YR 5/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 45 percent gravel; neutral (pH 6.8); clear smooth boundary.
A2—3 to 11 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; 50 percent gravel; neutral (pH 6.6); clear smooth boundary.
Bt1—11 to 15 inches; dark brown (10YR 3/3) extremely gravelly clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine and medium roots; few fine and medium tubular pores; few distinct clay films on faces of peds and lining pores; 60 percent gravel; neutral (pH 6.6); clear smooth boundary.
Bt2—15 to 18 inches; dark brown (10YR 3/3) extremely gravelly clay, brown (10YR 5/3) dry; strong fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and medium tubular pores; many distinct clay films on faces of peds and lining pores; 70 percent gravel; slightly acid (pH 6.4); abrupt smooth boundary.
R—18 inches; fractured sedimentary rock.

Depth to sedimentary rock is 10 to 20 inches. The mollic epipedon is 10 to 20 inches thick. The particle-size control section averages 35 to 50 percent clay and 60 to 70 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 35 to 55 percent gravel.

The Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is clay loam or clay and is 60 to 70 percent gravel.

Walsey Series

The Walsey series consists of moderately deep, well drained soils in canyons. These soils formed in residuum and colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 2 to 55 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Walsey extremely cobbly silt loam in an area of Walsey-Axford complex, 30 to 55 percent slopes, in an area of rangeland; 1,500 feet north and 1,500 feet west of the southeast corner of sec. 11, T. 8 S., R. 13 E.

A—0 to 6 inches; very dark brown (10YR 2/2) extremely cobbly silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; soft, friable, nonsticky and nonplastic; many very fine, fine, and medium roots; many very fine, fine, and medium irregular pores; 45 percent cobbles and 25 percent gravel; neutral (pH 7.0); clear smooth boundary.

AB—6 to 11 inches; very dark brown (10YR 2/2) extremely cobbly silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; many very fine, fine, and medium tubular pores; 40 percent cobbles and 20 percent gravel; neutral (pH 7.0); clear smooth boundary.

Bt—11 to 19 inches; dark brown (10YR 3/3) very cobbly silty clay loam, yellowish brown (10YR 5/4) dry; strong medium subangular blocky structure; hard, very firm, sticky and plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores and few medium tubular pores; common distinct blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; neutral (pH 7.0); clear wavy boundary.

Bt1—22 to 35 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; common faint clay films on faces of peds; neutral (pH 7.2); clear smooth boundary.

Bt2—35 to 44 inches; dark yellowish brown (10YR 3/4) clay loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few very fine and fine tubular pores; many distinct clay films on faces of peds and lining pores; 5 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

2C—44 to 58 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine tubular pores; 10 percent gravel; mildly alkaline (pH 7.6); abrupt smooth boundary.

2R—58 inches; basalt with discontinuous silica cap 1 millimeter thick.

Depth to basalt ranges from 40 to 60 inches. The mollic epipedon is 20 to 35 inches thick. The particle-size control section averages 27 to 35 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 0 to 10 percent gravel.

The Bt horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is clay loam or silty clay loam and is 0 to 10 percent gravel.

Watama Series

The Watama series consists of moderately deep, well drained soils on mesas. These soils formed in colluvium derived dominantly from basalt with an influence of loess in the upper part. Slopes are 0 to 30 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Watama silt loam in an area of Watama-Rockly complex, 0 to 8 percent slopes, in an area of rangeland; 200 feet east and 300 feet south of the northwest corner of sec. 24, T. 8 S., R. 11 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thin and medium platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; neutral (pH 6.8); clear smooth boundary.

A2—4 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky

structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; neutral (pH 7.0); clear smooth boundary.

Bw1—11 to 21 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots and few medium roots; common very fine and fine tubular pores; neutral (pH 7.2); clear smooth boundary.

Bw2—21 to 28 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; mildly alkaline (pH 7.4); clear smooth boundary.

Bw3—28 to 37 inches; dark yellowish brown (10YR 3/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; mildly alkaline (pH 7.4); abrupt wavy boundary.

2R—37 inches; basalt.

Depth to basalt is 20 to 40 inches. The profile has hue of 7.5YR or 10YR. The mollic epipedon is 20 to 30 inches thick. The particle-size control section averages 20 to 30 percent clay.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It has platy or subangular blocky structure. It is silt loam or gravelly silt loam and is 0 to 20 percent gravel.

The Bw horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam, gravelly silt loam, or silty clay loam and is 0 to 20 percent gravel and 0 to 5 percent cobbles.

Waterbury Series

The Waterbury series consists of shallow, well drained soils in canyons. These soils formed in colluvium derived dominantly from basalt. Slopes are 2 to 80 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Waterbury extremely stony loam in an area of Waterbury-Kishwalk complex, 2 to 30 percent slopes, in an area of rangeland; 1,800 feet east and 2,500 feet south of the northwest corner of sec. 21, T. 8 S., R. 12 E.

A—0 to 3 inches; very dark brown (10YR 2/2) extremely stony loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine irregular pores; 40 percent stones, 20 percent cobbles, and 5 percent gravel; neutral (pH 7.0); clear smooth boundary.

AB—3 to 8 inches; very dark brown (10YR 2/2) very stony clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent stones, 20 percent cobbles, and 5 percent gravel; neutral (pH 6.8); abrupt smooth boundary.

Bt1—8 to 11 inches; very dark grayish brown (10YR 3/2) extremely stony clay, grayish brown (10YR 5/2) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; many prominent clay films on faces of peds and lining pores; 45 percent stones and 20 percent cobbles; neutral (pH 6.6); clear smooth boundary.

Bt2—11 to 16 inches; dark brown (7.5YR 3/4) extremely stony clay, brown (7.5YR 4/4) dry; strong coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine tubular pores; many prominent clay films on faces of peds and lining pores; 50 percent stones and 20 percent cobbles; neutral (pH 6.6); abrupt smooth boundary.

R—16 inches; basalt.

Depth to bedrock is 12 to 20 inches. The particle-size control section averages 50 to 60 percent clay. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 1 or 2 moist or dry. It is 30 to 45 percent stones, 10 to 30 percent cobbles, and 5 to 10 percent gravel.

The AB horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is clay loam or silty clay loam. The horizon is 20 to 30 percent stones, 10 to 20 percent cobbles, and 5 to 10 percent gravel.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 4 or 5 dry, and chroma of 2 to 4

moist or dry. It is 30 to 50 percent stones, 10 to 20 percent cobbles, and 5 to 10 percent gravel.

Willowdale Series

The Willowdale series consists of very deep, well drained soils on flood plains. These soils formed in alluvium derived from mixed sources. Slopes are 0 to 3 percent. The mean annual precipitation is about 10 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Willowdale loam, 0 to 3 percent slopes, in an area of rangeland; 890 feet west and 110 feet south of the northeast corner of sec. 17, T. 9 S., R. 15 E.

Ap1—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine irregular pores; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Ap2—5 to 11 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; massive; hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine tubular pores; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Ak1—11 to 18 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure and weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; strongly effervescent with segregated lime in soft masses; 15 percent pumice sand; moderately alkaline (pH 8.2); abrupt wavy boundary.

Ak2—18 to 24 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure and moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; strongly effervescent with segregated lime in soft masses; 10 percent pumice sand; moderately alkaline (pH 8.3); abrupt wavy boundary.

ACk—24 to 40 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; strongly effervescent with segregated lime in soft masses; moderately alkaline (pH 8.4); clear wavy boundary.

Ck1—40 to 48 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; strongly effervescent with segregated lime in soft masses; moderately alkaline (pH 8.4); clear smooth boundary.

2Ck2—48 to 60 inches; variegated sand and gravel; loose; nonsticky and nonplastic; strongly effervescent with disseminated lime; moderately alkaline (pH 8.4).

Depth to the 2Ck horizon is 40 to 60 inches. Depth to bedrock is more than 60 inches. The particle-size control section is 0 to 10 percent sand-sized pumice and 18 to 27 percent clay.

The Ap horizon has value of 2 or 3 moist and 3 or 4 dry, and it has chroma of 2 or 3 moist or dry. It is 0 to 10 percent gravel.

The Ak and ACk horizons have value of 2 or 3 moist and 4 or 5 dry, and they have chroma of 2 or 3 moist or dry. They are loam, gravelly sandy loam, or sandy loam and are 0 to 20 percent gravel.

The Ck1 horizon has value of 3 or 4 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is sandy clay loam, sandy loam, or loam and is 0 to 20 percent gravel and 0 to 5 percent cobbles.

Xerofluvents

Xerofluvents are very deep, somewhat poorly drained to well drained soils on flood plains. These soils formed in medium textured or moderately fine textured alluvium derived from mixed sources. Slopes are 0 to 3 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 50 degrees F.

Reference pedon of Xerofluvents, 0 to 3 percent slopes; 1,100 feet south and 600 feet east of the northwest corner of sec. 28, T. 8 S., R. 12 E.

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 15 percent gravel and 5 percent cobbles; neutral (pH 7.0); clear smooth boundary.

A2—6 to 15 inches; brown (10YR 4/3) very gravelly loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure parting

to weak fine granular structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel and 10 percent cobbles; mildly alkaline (pH 7.4); abrupt smooth boundary.

2C1—15 to 31 inches; dark brown (7.5YR 4/2) extremely cobbly sandy clay loam, brown (7.5YR 5/3) dry; massive; hard, firm, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; 50 percent cobbles and 30 percent gravel; mildly alkaline (pH 7.4); clear smooth boundary.

2C2—31 to 43 inches; dark brown (7.5YR 4/2) extremely cobbly sandy loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 40 percent cobbles and 30 percent gravel; mildly alkaline (pH 7.4); gradual wavy boundary.

2C3—43 to 60 inches; dark brown (7.5YR 4/3) extremely cobbly loamy sand, brown (7.5YR 5/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; 40 percent cobbles and 30 percent gravel; neutral (pH 7.2).

Depth to bedrock is more than 60 inches. Depth to the 2C horizon is 15 to 40 inches or more.

The A horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 2 to 4 moist or dry. It is sandy loam, loam, or silt loam. The horizon is 10 to 30 percent gravel and 0 to 10 percent cobbles.

The 2C horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 2 to 4 moist or dry. It is sandy clay loam, loam, sandy loam, or loamy sand. The horizon is 15 to 50 percent gravel and 10 to 40 percent cobbles.

Yawkola Series

The Yawkola series consists of very deep, well drained soils on mountainsides. These soils formed in residuum and colluvium derived dominantly from sedimentary rock with an influence of volcanic ash in the upper part. Slopes are 2 to 55 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Yawkola very gravelly silt loam in an area of Yawkola-Jorn-Rock outcrop complex, 2 to 30 percent slopes, in an area of woodland; 100 feet west and 1,800 feet north of the southeast corner of sec. 24, T. 6 S., R. 11 E.

Oi—1 inch to 0; organic layer of needles and twigs

A1—0 to 7 inches; very dark grayish brown (10YR 2/2) very gravelly silt loam, grayish brown (10YR 5/2) dry; moderate medium platy structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 30 percent gravel and 15 percent cobbles; neutral (pH 6.8); abrupt smooth boundary.

A2—7 to 11 inches; very dark grayish brown (10YR 3/2) very gravelly silt loam, grayish brown (10YR 5/2) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine, fine, medium, and coarse roots; many very fine, fine, medium, and coarse irregular pores; 35 percent gravel and 15 percent cobbles; neutral (pH 6.8); abrupt smooth boundary.

2Bt1—11 to 30 inches; dark brown (10YR 3/3) very gravelly silty clay, brown (10YR 5/3) dry; strong coarse prismatic structure parting to moderate medium subangular blocky; extremely hard, extremely firm, sticky and plastic; many very fine and fine roots and common medium and coarse roots; many very fine and fine tubular pores and common medium and coarse tubular pores; continuous prominent clay films on faces of peds and lining pores; 35 percent gravel and 15 percent cobbles; slightly acid (pH 6.4); clear smooth boundary.

2Bt2—30 to 40 inches; dark yellowish brown (10YR 3/4) extremely gravelly silty clay, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; common very fine and fine roots; common very fine and fine tubular pores; continuous prominent clay films on faces of peds and lining pores; common fine manganese stains; 45 percent gravel and 20 percent cobbles; slightly acid (pH 6.2); clear smooth boundary.

3Bt3—40 to 60 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate medium and fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; common distinct clay films; 25 percent gravel; slightly acid (pH 6.2).

Depth to sedimentary rock is more than 60 inches. The mollic epipedon is 20 to 30 inches thick, and it includes all or part of the argillic horizon. The particle-size control section is 40 to 50 percent clay and 45 to 70 percent rock fragments.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and it has chroma of 2 or 3 moist or dry. It is 10 to 20 percent clay and is 25 to 40 percent gravel and 5 to 15 percent cobbles.

The 2Bt horizon has value of 3 or 4 moist and 4 or 5 dry, and it has chroma of 3 or 4 moist or dry. It is silty clay or clay and is 40 to 50 percent clay. It is 35 to 50 percent gravel and 10 to 25 percent cobbles.

The 3Bt horizon has value of 4 or 5 moist and 5 or 6 dry, and it has chroma of 3 or 4 moist or dry. It is silt loam or loam and is 20 to 27 percent clay. It is 20 to 30 percent gravel.

Formation of the Soils

Soil is the collection of natural bodies on the Earth's surface that contains living matter and is capable of supporting plants *(5)*. The nature of a soil depends upon the combination and interaction of five factors—climate, plant and animal life, parent material, topography, and time.

The relative influence of each factor varies from place to place, and in some places a single factor can determine most properties of the soil. Parent material, climate, and topography are responsible for most differences in the soils in this survey area.

In this section the soil-forming factors of climate and plant and animal life are discussed separately. The factors of time, parent material, and topography are grouped together and discussed under the heading "Geomorphic Surfaces and Soil Development."

Climate

Climate, particularly moisture and temperature, greatly influences soil formation. The chemical and physical reactions taking place in the soil largely are influenced by climate. Water dissolves soluble material in the soil, and it transports material from one part of the soil to another. Water is necessary for the growth of plants and soil organisms that contribute organic matter to the soil.

Temperature affects the rate of chemical reactions and of physical breakdown as a result of the freezing of water. Freezing and thawing of water cause expansion and contraction and influence the movement of soil particles and rock fragments in the soil. The kind and amount of living organisms in and on the soil determine the kind and amount of organic matter added to the soil. The rate of decomposition of the organic matter is influenced by temperature and moisture.

In this survey area, there are five major moisture and temperature zones that greatly influence soil genesis.

In *moisture and temperature zone 1*, summers are hot and dry and winters are cool and moist. The growing season is long; plant growth begins early in spring and continues through midsummer. Elevation is 1,100 to 2,800 feet, and the average annual precipitation is about 9 to 12 inches. The soils in this zone have an aridic moisture regime and a mesic soil temperature regime *(19)*. The soils are dominantly in general soil map units 1, 2, 3, and 4.

On the young surfaces in zone 1, such as flood plains, the soils are moist for long periods, which allows for abundant plant growth and organic matter accumulation. Cumulic Haploxerolls and Torrifluventic Haploxerolls have formed on these surfaces. On the older surfaces, such as terraces, arid foothills, and canyons, the soil-forming factors have been active for long periods of time. Aridic Calcic Argixerolls, Aridic Argixerolls, Aridic Palexerolls, and Lithic Argixerolls have formed on these surfaces. On the active surfaces in this zone, Lithic Haploxerolls have formed.

In *moisture and temperature zone 2*, summers are hot and dry and winters are cool and wet. The growing season is long; plant growth begins late in spring and continues through late in summer. The soils in this zone have a xeric moisture regime and a mesic soil temperature regime. Elevation is 1,800 to 3,800 feet, and the average annual precipitation is about 12 to 25 inches. The soils are dominantly in general soil map units 5, 6, 7, 8, 9, 10, and 11. They are on foothills, mesas, outwash plains, and mountains and in canyons. These soils support contrasting vegetative types that are adapted to the various soils and their topography.

On the younger, active surfaces in zone 2, soil formation is minimal. Pachic Haploxerolls, Ultic Haploxerolls, Vitrandic Haploxerolls, and Lithic Haploxerolls have formed on these surfaces. On the older, metastable and stable surfaces, the soil-forming factors have been active for long periods of time. Pachic Argixerolls, Pachic Palexerolls, Vitrandic Argixerolls, Typic Durixerolls, Vitrandic Haploxeralfs, and Alfic Vitrixerands have formed on these surfaces.

In *moisture and temperature zone 3*, summers are hot and dry and winters are cold and wet. The growing season is shorter than that in warmer areas at the lower elevations. The soils in this zone have a xeric moisture regime and a frigid soil temperature regime. Elevation is 2,200 to 4,500 feet, and the average annual precipitation is about 20 to 40 inches.

The soils are on stream terraces and mountains and are in general soil map unit 12.

On the younger, active surfaces in zone 3, soil formation is minimal. Ultic Haploxerolls, Typic Vitrixerands, and Humic Vitrixerands have formed on these surfaces. On the older, metastable and stable surfaces, the soil-forming factors have been active for long periods of time. Pachic Ultic Argixerolls and Alfic Vitrixerands have formed on these surfaces.

In *moisture and precipitation zone 4*, summers are warm and moist and winters are cool and wet and are characterized by abundant rain and snow. The growing season is shorter than that in warmer areas at the lower elevations. The soils in this zone have a udic moisture regime and a frigid soil temperature regime. Elevation is 3,000 to 5,600 feet, and the average annual precipitation is 40 to 90 inches. The soils are dominantly in general soil map unit 13.

This zone is typified by active surfaces on steep mountains, where Typic Udivitrands have formed, and by stable benches, where Alfic Udivitrands have formed.

In *moisture and precipitation zone 5*, summers are cool and moist and winters are cold and wet and are characterized by abundant snow. The growing season is very short as compared to that of the lower elevations. The soils in this zone have a udic moisture regime and a cryic soil temperature regime. Elevation is 4,200 to 10,500 feet, and the average annual precipitation is 70 to 110 inches. The soils are dominantly in general soil map units 14 and 15.

This zone is typified by active surfaces on steep mountains, where Vitric Haplocryands and Typic Vitricryands have formed, and by stable benches, where Alfic Vitricryands have formed.

Living Organisms

Living organisms, especially the higher plants, are active in soil formation. The changes they bring about depend mainly on the life processes peculiar to each kind of organism. The kinds of organisms that live on and in the soil are determined, in turn, by climate; parent material; topography, or relief; and the age of the soil. In this survey area, climate is the dominant soil-forming factor that affects vegetation.

Plants provide a cover that helps to reduce erosion and stabilize the soil surface. Leaves, twigs, roots, and the remains of entire plants accumulate on the surface of soils and are decomposed by micro-organisms, earthworms, and other soil fauna. Plant roots widen cracks in the underlying rock, permitting water to penetrate. The uprooting of trees by wind also mixes soil layers and loosens the underlying material. Plants contribute to important processes, such as organic matter accumulation, mixing of the profile, cycling of nutrients, stabilization of soil structure, and addition of nitrogen.

In this survey area, the soils formed under two major types of plant cover. Grasses and shrubs are dominant in the warmer, more dry areas, and conifer forests are dominant in the cooler, more moist areas.

Small animals, earthworms, insects, and micro-organisms influence the formation of soils in several ways. They mix organic matter into the mineral soil material and accelerate the decomposition of organic matter by breaking down the remains of plants. Small animals burrow into the soil and mix the layers. Earthworms and other small invertebrates feed on the organic matter in the upper few inches of soil material. They slowly, but continually, mix the soil material and alter its chemistry. Bacteria, fungi, and other micro-organisms hasten the weathering of rocks and the decomposition of organic matter.

Conditions in the survey area are generally favorable for most organisms. Earthworms are very common in all areas except in the cooler frigid and cryic soil temperature zones. Small animals, such as gophers, moles, and ground squirrels, are common throughout the survey area.

Man has also played a prominent role in soil development by leveling agricultural soils on Schoolie Flat and in The Island area.

Geomorphic Surfaces and Soil Development

Geomorphic surfaces consist of a landform or group of landforms that represent an episode of landscape development. In general, landforms exhibit more soil development as the age of the landscape increases. The kind of soil associated with a surface is the result of the interaction of parent material, climate, topography, and living organisms. In soil genesis, the factor of time is considered a constant.

The major landforms recognized in the survey area are flood plains, terraces, foothills, canyons, mesas, outwash plains, and mountains.

Within the major upland landforms (foothills, canyons, mesas, outwash plains, and mountains), three significant gradient breaks have been recognized and correspond to active, metastable, and stable slopes *(15)*. In general, soils that exhibit the least amount of soil development formed on active slopes, soils that exhibit stronger development formed on metastable slopes, and soils that exhibit the strongest soil development formed on stable slopes. Differences among the active, metastable, and stable

slopes are reflected in the composition of the parent material and the slope gradients.

Flood plains. This is the oldest surface related to the present drainage systems in the survey area. Most of this surface has morphology typical of abandoned flood plains of aggrading streams, and it is characterized by bar and channel topography with a defined backswamp in some areas. Relief between the bars and channels is largely a result of the competence of the stream that flowed through the area. This surface is dominantly adjacent to the Deschutes River, the Warm Springs River, and Shitike Creek, generally at elevations of 1,100 to 1,600 feet. Geomorphically, it is between the active flood plain, which was too insignificant to be recognized in this survey area, and the older terraces above the valley floors. It is considered to be middle to early Holocene. Sediment associated with this surface is dominantly fine sand and clay, and it commonly is underlain by stratified sand and gravel at a depth of 4 to 6 feet.

Horizon development in the soils on the flood plains is mainly limited to the accumulation of organic matter. Cumulic Haploxerolls, such as the Willowdale soils, are dominant on this surface. These soils have a mollic epipedon and an irregular decrease in organic matter as depth increases. Torrifluventic Haploxerolls, such as the Pelton soils, also are common on this surface. These soils have a cambic horizon, which is an indication of some soil development. Other soils associated with flood plains are Cumulic Endoaquolls, such as the Olallie soils.

Stream terraces. This surface occurs as older stream terraces adjacent to major streams in the survey area. It is above the valley floors and consists of the lowest terraces not related to the present drainage systems. The most extensive area of this surface exhibits low relief and slight incision by drainageways. This surface is dominantly adjacent to Dry Creek, Tenino Creek, Dry Hollow Creek, and the Warm Springs River, at elevations of about 1,200 to 2,000 feet. Geomorphically, it is between the flood plains and low foothills and is considered to be late Pleistocene. Sediment associated with this surface is dominantly silt and clay.

Soils on this surface exhibit stronger development than the soils on younger geomorphic surfaces in the survey area. This is partially because of the time available for pedogenesis to take place. Aridic Calcic Argixerolls, such as the Drybed soils, are dominant on this surface. These soils have a well-developed argillic horizon and an accumulation of carbonates in the subsoil.

Low foothills. This surface is the oldest geomorphic surface related to the major streams in the survey area. It occurs as remnants of extensive flats that have been dissected to form rolling topography above the main valley floor. It is dominantly adjacent to Tenino Creek and Dry Creek and on fans adjacent to the higher foothills of the Mutton Mountains. Elevation is about 1,400 to 2,400 feet. Geomorphically, this surface is between the stream terraces and foothills of canyons and mountains. It is considered to be early to middle Pleistocene because of its position on the landscape. Typically, these low foothills have gently sloping tops and highly dissected sides that have slopes of 30 to 80 percent.

Soils on this surface exhibit much stronger development than the soils on other geomorphic surfaces in the survey area because of the older age of the surface and, therefore, the time available for pedogenesis to take place. Aridic Calcic Argixerolls, such as the Lavey soils, are dominant on this surface. These soils are clayey and have a strongly developed argillic horizon and an accumulation of calcium carbonates in the subsoil. The soils are underlain by welded tuff of the Deschutes Formation. Other soils associated with this surface are Aridic Argixerolls, such as the Madras and Skoven soils.

High foothills. This surface is on the oldest geological formation in the survey area, the Clarno Formation, which is considered to be middle Eocene and early Oligocene, or about 30 to 50 million years old. It consists of very resistant andesitic and basaltic rock, breccia, tuff, and tuffaceous siltstone. In many places, the top layer of the Clarno Formation is distinctive soft, reddish residual clay or silt saprolite *(23)*. This surface is dominantly adjacent to the Mutton Mountains and Laughlin Hills and below canyonsides in the eastern part of the survey area. Elevation is about 1,400 to 3,800 feet. Slopes range from 0 to 55 percent, but they typically are less than 30 percent.

The degree of soil development on this surface reflects long periods of geologic time. Soils on these stable slopes exhibit strong development, are clayey, and do not have rock fragments in the profile. Soils associated with this surface are Chromic Haploxererts, such as the Day soils; Typic Haploxererts, such as the Kaskela soils; Pachic Palexerolls, such as the Prill soils; Aridic Palexerolls, such as the Simas soils; and Xeric Paleargids, such as the Sorf soils.

Canyons. This surface occurs on fluvial and lacustrine sediment of the Deschutes Formation,

which was deposited 2 to 6 million years ago. Included in the formation are welded tuff as well as interbedded basalt flows that form rimrock (fig. 20). The canyons trend west to east and are represented by precipitous walls 400 to 800 feet high. They are dominantly along major drainageways in the eastern half of the survey area, from the Mutton Mountains south to the Metolius River. Elevation is about 1,200 to 3,000 feet. Slopes range from 12 to 80 percent, but they typically are less than 55 percent.

Figure 20.—A cross section of various depositions along Seekseequa Creek, showing the complex geology in the survey area. The three major deposits are tuff composed of sand-sized ashfall in the lower third, various debris-flow deposits in the middle third, and columnar basalt of the Columbia River Basalt Group in the upper third.

Soils on these metastable slopes exhibit moderate development, are loamy or clayey, and have a high content of rock fragments in the profile. Soils on north-facing slopes have an influence of loess in the surface layer and a significant amount of organic matter. Soils associated with this surface are Pachic Argixerolls, such as the Kishwalk and Sagley soils; Aridic Calcic Argixerolls, such as the Axford and Walsey soils; Aridic Argixerolls, such as the Ruclick soils; and Vitrandic Argixerolls, such as the Booten soils.

Other soils associated with this surface, typically in areas that have slopes of more than 55 percent, are Lithic Haploxerolls, such as the Lickskillet soils, and Lithic Argixerolls, such as the Waterbury and Ruckles soils.

In the southeastern corner of the survey area, where the rimrock has been eroded, deep beds of pumice are exposed and the soils reflect properties of those on active slopes. The soils in this area exhibit very little development, are sandy or loamy, and have an influence of volcanic ash throughout the profile. Soils associated with this area are Vitrandic Haploxerolls, such as the Shiva soils; Vitritorrandic Haploxerolls, such as the Dryhollow soils; Vitrandic Xerochrepts, such as the Happus soils; and Vitrixerandic Haplocambids, such as the Suppah soils.

Mesas. This surface occurs as nearly level to gently rolling mesas underlain by basalt flows from Cascade Range shield volcanoes of the early Pliocene. It is in the central part of the survey area, flanked by the Cascade Range to the west and precipitous canyons to the east. Also included in this surface are small areas of the Columbia River Basalt Group, northeast of Warm Springs and north of the Mutton Mountains, that consist of Miocene flood basalt flows. Elevation is about 2,500 to 3,600 feet. Slopes range from 0 to 8 percent.

This surface represents a kind of ground surface that commonly occurs under glacial influence. It is referred to as patterned ground, locally called “biscuit scabland” (see fig. 15, page 135). The main climatic significance of the soil patterns on this surface is that frozen ground apparently existed in front of the continental glacier during glacial invasion. A regular pattern of polygonal fractures could have formed in ground frozen to a uniform depth as a result of contraction during periods of subfreezing temperatures. Ice wedges could have formed in these fractures if the temperature fluctuated but generally remained below freezing *(12)*. As the climate became warmer and the front of the continental glacier retreated northward, the ice wedges apparently began to melt. The runoff could have caused the erosion and modification of the polygons, or mounds. Also, frost heaving probably mixed the genetically formed horizons. The removal of large amounts of mineral soil in the formation of the mounds is evident from the scabland that surrounds the mounds. The soils in the scablands formed mainly in remnants of material not removed during the thawing of the ice wedges and in material more recently washed from the mounds.

Although this surface is stable, the soils exhibit weak development, are silty, and have an influence of loess in the surface layer. Soils associated with this surface are Lithic Haploxerolls, such as the Bakeoven and Rockly soils; Pachic Haploxerolls, such as the Watama soils; and Pachic Argixerolls, such as the Wapinitia soils. Soils on the part of this surface associated with the Columbia River Basalt Group are Haploduridic Durixerolls, such as the Maupin soils.

Outwash plains. This surface occurs as Pleistocene glacial outwash deposits underlain by

basalt flows from shield volcanoes of the early Pliocene. It is in the central part of the survey area, flanked by the Cascade Mountains to the west and basalt mesas to the east. Elevation is about 2,500 to 3,000 feet. Slopes range from 0 to 20 percent, but they typically are less than 8 percent.

Soils on this stable surface exhibit moderate to strong development, are loamy or clayey, and have an influence of loess and volcanic ash in the surface layer. Soils associated with this surface are Typic Durixerolls, such as the Milldam soils; Palexerollic Durixerolls, such as the Tenwalter soils; Argic Duraquolls, such as the Kahneeta soils; and Vitrandic Argixerolls, such as the Skooker and Tolius soils.

Mutton Mountains. This surface occurs on the John Day and Clarno Formations, the oldest geological formations in the survey area. The John Day Formation overlies the Clarno Formation and was formed in late Oligocene and early Miocene, or about 20 to 30 million years ago. It consists of air-fallen and waterlain ash, tuff, ashflow, welded tuff, and rhyolitic flows. The Clarno Formation was formed in middle Eocene and early Oligocene, or about 30 to 50 million years ago. It consists of very resistant andesitic and basaltic rock, breccia, tuff, and tuffaceous siltstone. In many places, the top layer of the Clarno Formation is a distinctive soft, reddish residual clay or silt saprolite *(5)*. North-facing slopes on this surface have deposits of air-fallen ash on the surface as a result of recent eruptions in the Cascade Range. This surface is in the northeastern corner of the survey area, and it is composed of the Mutton Mountains and Laughlin Hills. Elevation is about 1,200 to 4,500 feet. On the John Day Formation, slopes range from 2 to 80 percent but they typically are more than 30 percent. On the Clarno Formation, slopes range from 2 to 55 percent but they typically are less than 30 percent.

Soils on the active slopes associated with the John Day Formation exhibit weak development, are ashy or loamy, and have a high content of rock fragments in the profile. Soils associated with these slopes are Typic Haploxerolls, such as the Oldsferry soils; Ultic Haploxerolls, such as the Mowako soils; Vitrandic Haploxerolls, such as the Eaglespring and Peahke soils; and Typic Vitrixerands, such as the Kusu soils.

Soils on the stable slopes associated with the Clarno Formation exhibit strong development, are ashy or clayey, and typically do not have rock fragments in the profile. Soils associated with these slopes are Pachic Palexerolls, such as the Fawnspring and Yawkola soils; Vitrandic Haploxeralfs, such as the Boardflower, Littlefawn, Logsprings, and Mutton soils; and Vitrandic Argixerolls, such as the Jorn soils.

Cascade Mountains. This surface occurs on andesite flows from Cascade Range volcanoes of the late Pliocene that are buried in volcanic ash from recent eruptions in the Cascade Range. This surface encompasses the entire Cascade Range, in the western third of the survey area, and it occurs as broad, level to rolling lava flows with precipitous side slopes along major drainageways. Elevation is about 2,600 to 10,500 feet. On the stable tops and metastable shoulders of this surface, slopes range from 0 to 40 percent but they typically are less than 30 percent. On the active, precipitous side slopes of drainageways, slopes range from 12 to 70 percent but they typically are more than 30 percent.

Soils on the stable and metastable slopes of this surface exhibit moderate development in the subsoil, and they typically have a low content of rock fragments in the profile. Soils associated with these slopes are Vitrandic Argixerolls, such as the Hehe and Teewee soils; Alfic Vitrixerands, such as the Simnasho and Smiling soils; Alfic Udivitrands, such as the Kutcher and Mackatie soils; and Alfic Vitricryands, such as the Piumpsha soils.

Soils on the active slopes of this surface exhibit weak development and have a high content of rock fragments in the profile. The volcanic ash in the soils at the high elevations exhibits a higher degree of weathering than that in the soils at the lower elevations. Soils associated with the active slopes are Humic Vitrixerands, such as the Pipp soils; Typic Vitrixerands, such as the Grenet and Kusu soils; Typic Udivitrands, such as the Howash soils; Typic Vitricryands, such as the Jojo soils; and Vitric Haplocryands, such as the Pinhead soils.

References

(1) Alexander, R.R. 1967. Site index for Engelmann spruce. R.P. RM-32.

(2) Alexander, R.R. 1967. Site indexes for lodgepole pine with correction for stand density: Instructions for field use. R.P. RM-24.

(3) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols.

(4) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2497.

(5) Balster, C.A., and R.B. Parsons. 1968. Geomorphology and soils, Willamette Valley, Oregon. OR Agric. Exp. Sta. Spec. Rep. 265.

(6) Barnes, G.H. 1962. Yield of even-aged stands of western hemlock. Tech. Bull.1273.

(7) Cochran, P.H. 1979. Site index and height growth curves for managed, even-aged stands of Douglas fir east of the Cascades in Oregon and Washington. R.P. PNW-251.

(8) Cochran, P.H. 1979. Site index and height growth curves for managed, even-aged stands of white or grand fir east of the Cascades in Oregon and Washington. R.P. PMW-251.

(9) Haig, I.T. 1932. Second-growth yield, stand, and volume tables for the western white pine type. Tech. Bull. 323.

(10) Herman, F.R., R.O. Curtis, and D.J. DeMears. 1978. Height growth and site index estimates for noble fir in high elevation forests of the Oregon-Washington Cascades. R.P. PNW-243.

(11) Hoyer, Gerald E., and Francis R. Herman. 1989. Height-age and site index curves for Pacific silver fir in the Pacific Northwest. R.P. PNW-418.

(12) Kaatz, M.H. 1959. Patterned ground in central Washington: A preliminary report. Northwest Sci. 33:145-146.

(13) McArdle, R.E., W.H. Meyer, and D. Bruce. 1961. The yield of Douglas fir in the Pacific Northwest. Tech. Bull. 201.

(14) Meyer, W.H. 1938. Yield of even-aged stands of ponderosa pine. Tech. Bull. 630.

(15) Nettleton, W.D., R.B. Parsons, A.O. Ness, and F.W. Gelderman. 1982. Spodosols along the southwest Oregon coast. Soil Sci Soc. Am. Proc. 34: 485-491.

(16) Oregon State University Extension Service. 1980. Nutritive values of native foods of Warm Springs Indians. Ext. Circ. 809.

(17) Schmidt, W.C. 1976. Ecology and silviculture of western larch. Tech. Bull. 1520.

(18) Society of American Foresters. 1980. Forest cover types of the United States and Canada.

(19) United States Department of Agriculture, Natural Resources Conservation Service. 1996. Keys to soil taxonomy. 7th ed.

(20) United States Department of Agriculture, Soil Conservation Service. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18. (Supplements replacing pp. 173-188 issued May 1962)

(21) United States Department of Agriculture, Soil Conservation Service. 1970. Soil survey of Trout Creek-Shaniko Area, Oregon.

(22) United States Department of Agriculture, Soil Conservation Service. 1982. Soil survey of Wasco County, Oregon, Northern Part.

(23) United States Department of the Interior, Geological Survey. Water resources of the Warm Springs Indian Reservation, Oregon. Water Resour. Invest. 76-26, pp. 4.

(24) Wiley, K.N. 1970. Site index curves for western hemlock in the Pacific Northwest. Weyerhauser For. Pap.17.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Animal-unit-month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Ash. Fine, pyroclastic material less than 2 millimeters in all dimensions.

Ashflow. A highly heated mixture of volcanic gases and ash that moves down the flank of a volcano or along the surface of the ground. It is produced by the explosive disintegration of viscous lava in a volcanic crater or by the explosive emission of gas-charged ash from a fissure or group of fissures. The solid material in a typical ashflow generally is unsorted and includes volcanic dust, pumice, scoria, and blocks in addition to ash.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bar and channel relief. The microrelief common to flood plains and relatively young alluvial terraces. Over time, the microrelief becomes subdued as the higher lying bars erode into the channels. The ridgelike bars commonly consist of accumulations of coarse-textured sediment, and the channels are finer textured material. The relief between the bars and channels largely is related to the competence of the stream.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bog. Waterlogged, spongy ground consisting primarily of mosses and including acidic, decaying vegetation, such as sphagnum, sedges, and heaths, that develops into peat.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management. Use of mechanical, chemical, or biological methods to reduce or eliminate competition of woody vegetation to allow understory grasses and forbs to recover or to make conditions favorable for reseeding. Brush management increases production of forage and thus reduces the risk of erosion. It can improve the habitat for some species of wildlife.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees

generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Canopy. The leafy crown of trees or shrubs.

Canyon. A long, deep, narrow, steep-sided valley with high, precipitous walls in an area of high local relief.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chemical treatment. Control of unwanted vegetation by use of chemicals.

Cinder cone. A conical hill formed by the accumulation of volcanic ejecta, generally with slopes of more than 20 percent.

Cinders. Uncemented vitric, vesicular, pyroclastic material more than 2 millimeters in at least one dimension, with an apparent specific gravity (including vesicles) of more than 1.0 and less than 2.0.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent clay or more, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan commonly is hard when dry and plastic or stiff when wet.

Climax plant community. The plant community on a given site that will become established if present environmental conditions do not change and the site is properly managed.

Coarse fragments. Mineral or rock particles larger than 2 millimeters in diameter.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Compaction, soil. An alteration of soil structure that ultimately can affect the biological and chemical properties of soil. Soil compaction decreases voids and increases bulk density.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conglomerate. A coarse grained, clastic rock composed of rounded to subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Consistence, soil. The "feel" of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—Adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive, soil. High risk of corrosion of uncoated steel or of deterioration of concrete.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Debris flow (mass movement). A general term for a mass-movement landform and a process characterized by a flowing mass of dominantly coarse-grained material (particles more than 2 millimeters in diameter comprise more than 50 percent of the solid material) that has a high degree of fluidity during movement.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing or resting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—These soils have very high and high hydraulic conductivity and low water holding capacity. They are not suited to crop production unless irrigated.
Somewhat excessively drained.—These soils have high hydraulic conductivity and low water holding capacity. Without irrigation, only a narrow range of crops can be grown and yields are low.
Well drained.—These soils have intermediate water holding capacity. They retain optimum amounts of moisture, but they are not wet close enough to the surface or long enough during the growing season to adversely affect yields.
Moderately well drained.—These soils are wet close enough to the surface or long enough that planting or harvesting operations or yields of some field crops are adversely affected unless artificial drainage is provided. Moderately well drained soils commonly have a layer with low hydraulic conductivity, a wet layer relatively high in the profile, additions of water from seepage, or a combination of these.
Somewhat poorly drained.—These soils are wet close enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted unless artificial drainage is provided. Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water from seepage, or a combination of these.
Poorly drained.—These soils commonly are so wet at or near the surface during a considerable part of the year that field crops cannot be grown under natural conditions. Poorly drained conditions are caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these.
Very poorly drained.—These soils are wet to the surface most of the time. They are wet enough to prevent the growth of important crops (except rice) unless artificially drained.

Drainageway. A general term for a channel or course along which water moves from an area.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity*, or *capillary capacity*.

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foothill. A steeply sloping upland that has relief of as much as 1,000 feet (300 meters) and fringes a mountan range or high-plateau escarpment.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacier. A large mass of ice formed, at least in part, on land by the compaction and recrystallization of snow, creeping slowly downslope or outward in all directions because of the stress of its own weight, and surviving from year to year. Included are small mountain glaciers as well as ice sheets that are continental in size and ice shelves that float on the ocean but are fed in part by ice formed on land.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter. Very gravelly soil material is 35 to 60 percent of these rock fragments, and extremely gravelly soil material is more than 60 percent.

Ground water (geology). Water filling all the unblocked pores of the underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard rock. Rock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well-defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the "Soil Survey Manual." The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the number 2 precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The main consideration is the inherent capacity of bare soil to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A, at one extreme, are soils that have a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils that have a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net

irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	Very low
0.2 to 0.4	Low
0.4 to 0.75	Moderately low
0.75 to 1.25	Moderate
1.25 to 1.75	Moderately high
1.75 to 2.5	High
More than 2.5	Very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Mound. A low, rounded, natural or artificial hill of earth.

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides and considerable bare rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color in hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outcrop. That part of a geologic formation or structure that appears at the surface of the Earth.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An

outwash plain is commonly smooth; where pitted, it generally is low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan*, and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Patterned ground. A general term for any surface exhibiting a discernibly ordered, more or less symmetrical, morphological pattern of ground and, where present, vegetation. Patterned ground is characteristic of, but not confined to, permafrost regions or areas subjected to intense frost action. Patterned ground is classified by type of pattern and presence or absence of sorting and includes unsorted and sorted circles, nets, polygons, steps and stripes, garlands, and solifluction features. In permafrost regions, the most common macroform is the ice wedge polygon and a common microform is the unsorted circle. Stone polygons generally form on slopes of less than 8 percent, while garlands are on slopes of 8 to 15 percent and stripes are on slopes of more than 15 percent.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability, measured in inches per hour, is the rate that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	Less than 0.06
Slow	0.06 to 0.2
Moderately slow	0.2 to 0.6
Moderate	0.6 to 2.0
Moderately rapid	2.0 to 6.0
Rapid	6.0 to 20
Very rapid	More than 20

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential native plant community. (See climax plant community.)

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Pumice. A light-colored, vesicular, glassy rock commonly having the composition of rhyolite. It commonly is sufficiently buoyant to float on water.

Pyroclastic. Pertaining to fragmental material produced by usually explosive, aerial ejection of clastic particles from a volcanic vent. Such material may accumulate on land or under water.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill generally is a few inches deep and not wide enough to be an obstacle to farm machinery.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, gravel, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Rubble. Accumulation of loose angular rock fragments, commonly overlying rock outcroppings; the unconsolidated equivalent of breccia.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Scabland. An elevated, flat, basalt-floored area with little if any soil cover, sparse vegetation, and usually deep, dry channels scoured into the surface, especially by glacial meltwaters.

Scarification. The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The main kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are

similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shoulder. The landform position that forms the uppermost inclined surface near the top of a hillside. It comprises the transition zone from the backslope to the summit. The surface is dominantly convex and is erosional in origin.

Side slope. The slope bounding a drainageway and lying between the drainageway and the adjacent interfluve. It is generally linear along the slope width, and overland flow is parallel down the slope.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the following slope classes are recognized:

	Percent
Nearly level	0 to 2
Gently sloping	2 to 5
Moderately sloping	5 to 9
Strongly sloping	9 to 15
Moderately steep	15 to 30
Steep	30 to 50
Very steep	50 and higher

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Soft rock. Rock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the Earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 10 to 24 inches in diameter. Very stony soil material is 35 to 60 percent of these rock fragments, and extremely stony soil material is more than 60 percent.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. Structureless soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Tephra. A collective term for all clastic volcanic material that is ejected from a vent during an eruption and transported through the air, including volcanic ash, cinders, scoria, pumice, and blocks. Tephra is a general term which, unlike many volcaniclastic terms, does not denote properties of composition, vesicularity, or grain size.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Texture classes. The need for fine distinctions in the texture of the soil layers results in a large number of classes of soil texture. Often it is convenient to speak generally of broad groups or classes of texture (fig. 21). An outline of soil texture groups follows. In some areas where soils are high in silt, a fourth general class, *silty soils*, may be used for silt and silt loam.

Sandy soils
Coarse textured:
Sands—coarse sand, sand, fine sand, and very fine sand
Loamy sands—loamy coarse sand, loamy sand, loamy fine sand, and loamy very fine sand

Loamy soils
Moderately coarse textured:
Coarse sandy loam, sandy loam, and fine sandy loam
Medium textured:
Very fine sandy loam, loam, silt loam, and silt
Moderately fine textured:
Clay loam, sandy clay loam, and silty clay loam

Clayey soils
Fine textured:
Sandy clay, silty clay, and clay

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Tuff. Compacted deposit that is 50 percent or more volcanic ash and dust.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the Earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.

Yarding. A logging term referring to moving a log from the area in which it was cut to a landing or loading area.

Yarding, cable. Moving a log with a suspended cable rather than with a wheeled or tracked vehicle.

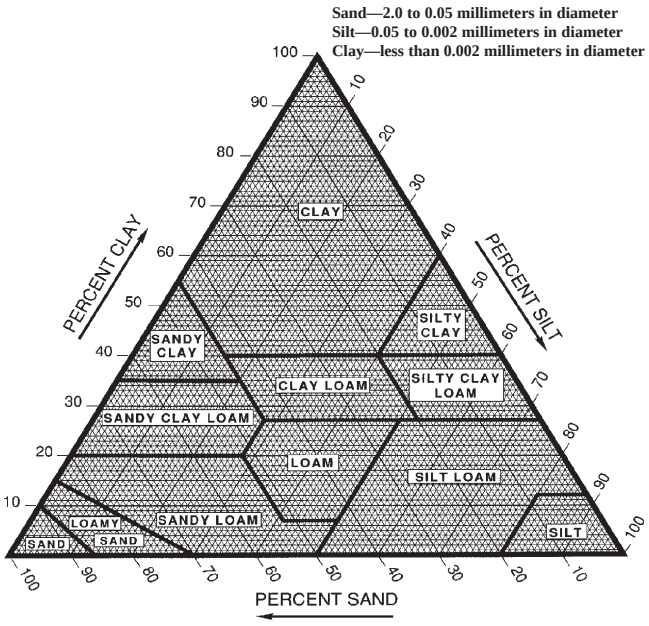


Figure 21.—U.S. Department of Agriculture textural classification chart.